



Natural History Museum Library



300009433



# BRITISH MUSEUM (NATURAL HISTORY).

---

## DAYS AND HOURS OF ADMISSION.

---

The Exhibition Galleries are open to the Public, free, every day of the week, except Sunday, in

January,	from 10 A.M. till 4	P.M.
February,	„ „ „ „	4.30 „
March,	„ „ „ „	5.30 „
April to August,	„ „ „ „	6 „
September,	„ „ „ „	5.30 „
October,	„ „ „ „	5 „
November and December,	„ „ „ „	4 „

Also, from May 1st to the middle of July, on Mondays and Saturdays only, till 8 P.M.,

and from the middle of July to the end of August, on Mondays and Saturdays only, till 7 P.M.

The Museum is closed on Good-Friday and Christmas-Day.

*By Order of the Trustees,*

W. H. FLOWER,

*Director.*

29 APR. 1898

# GUIDE

TO THE

## GALLERIES

OF

# REPTILES AND FISHES

IN THE

DEPARTMENT OF ZOOLOGY

OF THE

BRITISH MUSEUM (NATURAL HISTORY).



---

ILLUSTRATED BY 101 WOODCUTS.

---

[FOURTH EDITION.]

PRINTED BY ORDER OF THE TRUSTEES.

1898.

*Price Sixpence.*



GUIDE  
TO THE  
GALLERIES  
OF  
REPTILES AND FISHES  
IN THE  
DEPARTMENT OF ZOOLOGY  
OF THE  
BRITISH MUSEUM (NATURAL HISTORY).



ILLUSTRATED BY 101 WOODCUTS.

[FOURTH EDITION.]

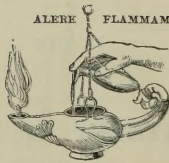
PRINTED BY ORDER OF THE TRUSTEES.  
1898.

(All rights reserved.)

a 421509



ALERE FLAMMAM



PRINTED BY TAYLOR AND FRANCIS,  
RED LION COURT, FLEET STREET.



## P R E F A C E.

---

THE dry and mounted specimens of Reptiles and Fishes are exhibited in two parallel Galleries on the west side of the ground floor behind the Bird Gallery. The Batrachians are contained in one large table-case placed in the cross gallery between the last named and the Fish Gallery.

This Guide gives a general account of the animals belonging to these three classes. The first edition was written by Dr. Günther, late Keeper of the Zoological Department, and published in 1887. The present (the fourth) edition has been revised by Mr. G. A. Boulenger, the changes being mostly in the sections devoted to the classes Reptilia and Batrachia. That of the Fishes, except for some corrections necessitated by alterations in the arrangement of the specimens, has been left much as written by Dr. Günther.

W. H. FLOWER,

*Director.*

January 31st, 1898.



# TABLE OF CONTENTS.

---

## THE REPTILE GALLERY.

	Page
General Notes on Reptiles . . . . .	1
Crocodylia (Crocodiles and Alligators) . . . . .	3
Rhynchocephalia (Tuatera) . . . . .	5
Lacertilia (Lizards) . . . . .	6
Ophidia (Snakes) . . . . .	16
Chelonina (Tortoises and Turtles) . . . . .	24
General Notes on Batrachians . . . . .	31
Tailless Batrachians (Frogs and Toads) . . . . .	33
Tailed Batrachians (Salamanders and Newts) . . . . .	42
Limbless Batrachians . . . . .	46

## THE FISH GALLERY.

General Notes on Fishes . . . . .	47
Acanthopterygii (Perches, Mackerels, &c.) . . . . .	58
Pharyngognathi (Wrasses) . . . . .	76
Anacanthini (Cod- and Flat-fishes) . . . . .	78
Physostomi (Carps, Herrings, &c.) . . . . .	82
Lophobranchii (Pipe-fishes) . . . . .	91
Plectognathi (File-, Globe-, and Sun-fishes) . . . . .	92
Ganoidei . . . . .	96
Chondropterygii (Sharks and Rays) . . . . .	100
Cyclostomata (Lampreys) . . . . .	112
Leptocardii (Lancelet) . . . . .	114



# THE REPTILE GALLERY.

---

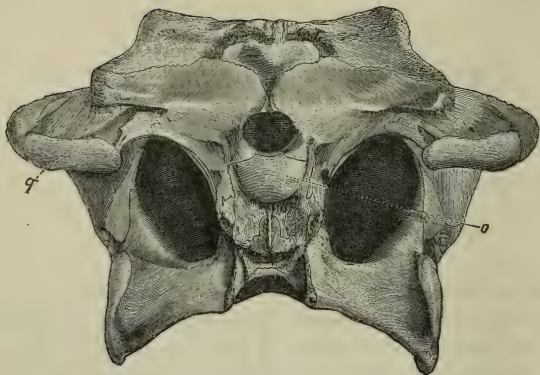
## GENERAL NOTES ON REPTILES.

THERE is but a short step from the Class of Birds to that of Reptiles. No doubt, as regards external appearance, the dissimilarity between the living animals of these two classes is sufficiently great to allow of a sharp line of demarcation being drawn between them: Birds being shortly characterized as warm-blooded vertebrate animals clothed with feathers, Reptiles as cold-blooded, and covered with horny or bony shields, tubercles, or "scales." But there are numerous and important agreements between these two classes, especially in the structure of their skeleton, in their internal organs, and their mode of propagation; and their close relationship becomes still more apparent when fossil forms, such as *Archæopteryx*, are examined.

Reptiles are termed "cold-blooded" because the temperature of their blood is raised but a few degrees above, and varies with, that of the outer atmosphere, owing to the imperfect separation of the divisions of their heart, which allows more or less of a mixture of the arterial and venous currents of the blood. Reptiles are oviparous or ovoviviparous; no important change takes place after exclusion from the egg; they breathe by lungs throughout life. Their skull articulates with the vertebral column by a single occipital condyle (see fig. 1), and their lower jaw with the skull by a separate bone (quadrate) (see figs. 1, 13, and 14).

The remains of the oldest known Reptiles, those found in the Perno-Carboniferous formations, belong to the Rhynchocephalian type, of which only one representative is still living (in New Zealand). Reptiles flourished and attained their greatest development in the Secondary period—Pterosaurians (large flying Lizards, see Guide

Fig. 1.



Back view of skull of Crocodile.

*o*, single occipital condyle; *g*, quadrate bone.

to Fossil Reptiles and Fishes, p. 1), Dinosaurians (huge terrestrial Reptiles far exceeding in size our largest Crocodiles, p. 8), Ichthyosaurians, and Plesiosaurians (large marine creatures, Geological Guide, pp. 32, 47), Dicynodonts (p. 55), Crocodiles, Lizards, and Turtles lived in abundance; Snakes, however, did not appear before the Tertiary period. At present some 4000 species of Reptiles are known, which are unequally divided among five Orders, viz. *Crocodylia* (Crocodiles and Alligators), *Rhynchocephalia*, *Lacertilia* (Lizards), *Ophidia* (Snakes), and *Chelonia* (Tortoises and Turtles).

In this classification of Reptiles the naturalist is guided much more by the structure of the skeleton and the other internal organs than by the external appearance. In fact, in Reptiles, as in many other classes of the Animal Kingdom, outward similarity is deceptive as to the natural relationship—that is, as to the degree in which they are related to each other as descendants from a more or less remote common ancestor. Take, for instance, a Crocodile, a Lizard, a Slowworm, and a Snake. The observer who, like the naturalists of the last and preceding centuries, is guided by external appearance only, would without hesitation place the Crocodile and

Lizard together, and associate the Slowworm with the Snake; whilst a study of their internal structure shows the Lizard and the Slowworm to be most closely related to each other, and both nearer to the Snake than to the Crocodile.

Reptiles are most abundant in hot climates, become less numerous in higher latitudes, and are altogether absent in the Arctic and Antarctic regions.

In the Gallery—

Wall-Cases 1- 9 contain the Crocodilians.

„	10	„	Rhynchocephalians.
„	10-17	„	Lizards.
„	18-22	„	Snakes.
„	23-44	„	Tortoises and Turtles.

Large specimens are exhibited separately on stands placed on the floor of the Gallery.

### Order I. CROCODILIA.

The Crocodilians differ in many anatomical characters from the Lacertilians, or true Lizards, with which they were formerly associated on account of their external resemblance. The organs of their chest and abdomen are separated from each other by a muscular diaphragm; their heart is divided into four cavities, as in the higher vertebrates. The ribs are provided with two heads for the articulation with the vertebræ, and with processes directed backwards; and their abdomen is protected by a series of transverse bones, as may be seen in the skeletons of the Gavial and Crocodile (opposite Wall-Cases 4-9). The teeth are implanted in sockets, while in other recent Reptiles they are grown to the bone of the jaws. The tongue is completely adherent to the floor of the mouth. The nostrils are situated close together on the upper side of the extremity of the snout; the eyes and the ears likewise are near to the upper profile of the head, so that the animal can breathe, see, and hear whilst its body is immersed in the water, the upper part of the head only being raised above the surface. When it dives, the nostrils are closed by valves, a transparent membrane is drawn over the eye, and the ear, which is a horizontal slit, is shut up by a movable projecting flap of the skin. The limbs are weak, the ante-

[Cases  
1-10.]



rior provided with five, the posterior with four digits, of which three only are armed with claws, and which are united together by a more or less developed web. The tail is long, compressed, crested above, very powerful, and admirably adapted for propelling the body through the water. The back, tail, and belly are protected by a dermal armour formed of quadrangular shields, of which the dorsal and, in several Alligators, also the ventral contain true bone.

The Crocodilians are thoroughly aquatic in their habits, and the most formidable of all the carnivorous freshwater animals. Crocodiles and Alligators, when young, and the Gharials throughout their existence, feed chiefly on fish; but large Crocodiles attack every animal which they can overpower, and which they drown before devouring. The eggs, of which one (of *Crocodilus porosus*) is exhibited in Case 4, are oblong, hard-shelled, and deposited in holes on the banks of rivers and ponds. The flesh of these animals is not eaten, but their hides have lately been introduced as an article of commerce; a portion of the skin prepared for the trade may be seen in Case 4.

The large stuffed Crocodilians are arranged in a row along the left side of the Gallery, those nearest the entrance being the Old-World forms, the other the American kinds. The smaller specimens occupy Wall-Cases 1-9.

About 25 species are known.

Crocodiles proper (*Crocodilus*) are distinguished from the Alligators by having the fourth lower tooth passing into a notch of the lateral edge of the upper jaw. They inhabit Africa, Southern Asia, the tropical parts of Australia, Central America, and the West Indies. The Indian Crocodile (*Crocodilus porosus*) is very common in the East Indies and Tropical Australia, and has been said to grow to a length of 30 feet. This, however, is very doubtful, as a very large specimen obtained in North-east Australia and exhibited in the Gallery measures only  $17\frac{1}{2}$  feet. The African Crocodile (*Crocodilus niloticus*) attains nearly to the same size as the Indian species. It was worshipped by the ancient Egyptians, and was once common in Egypt proper. It has now been almost exterminated in the lower parts of the Nile, but infests in great numbers all the freshwaters of Tropical Africa; and it is believed that more people are killed by Crocodiles than by any other of the wild beasts of Africa.

The false Gharial (*Tomistoma schlegelii*) is intermediate between Crocodiles and Gharials. It has long been known from Borneo, but its presence has recently been ascertained in Sumatra and the Malay Peninsula. A stuffed specimen from Perak is exhibited in a Case opposite to Wall-case 1.

The Gharials (*Gavialis*) may be readily recognized by their extremely long and slender snout. The Gharial of the Ganges (*G. gangeticus*), of which a large specimen and a skeleton are mounted in the middle of the Gallery opposite to the entrance, is abundant in that river and its tributaries, and attains to a length of about 16 feet. It feeds chiefly on fishes, for the capture of which its long and slender snout and sharp teeth are well adapted, but occasionally devours human bodies. Old males have a large cartilaginous hump on the extremity of the snout containing a small cavity, the use of which is not known.

In the Alligators (*Alligator*) the fourth lower tooth is received in a pit in the upper jaw, when the mouth is shut. With the exception of one species which occurs in the Yang-tse-kiang (*Alligator sinensis*), they are found only in America. They do not grow to the large size of the true Crocodiles. The species most generally known is *A. mississippiensis*, which abounds in the southern parts of North America. The Black Alligators (*Caiman niger* and *sclerops*) are common in South America as far south as 32° lat. S.

[Cases  
7-9.]

## Order II. RHYNCHOCEPHALIA.

Of this Order, which seems in the Permian and subsequent formations to have been represented by various genera, one species only has survived to our period. It is the *Tuatera* of the Maoris, or *Hatteria* or *Sphenodon* of naturalists. Case 11 contains examples of this interesting Reptile, with skeleton and skulls. It is the largest of the few Reptiles inhabiting New Zealand, but scarcely attains to a length of 2 feet. Formerly it was found in several parts of the northern island and in the Chatham Islands; but at present it is restricted to a few small islands in the Bay of Plenty and Cook's Straits, where it lives in holes, feeding on lizards, insects, worms, and other small animals. Externally there is nothing to distinguish

[Case 11.]

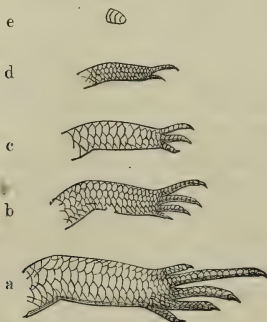
the *Tuatera* from ordinary Lizards; but important differences obtain in the structure of its skeleton, viz. the presence of a double horizontal bar across the temporal region, the firm connection of the quadrate bone with the skull and pterygoid bones, biconcave vertebræ (as in Geckos and many fossil Crocodilians), the presence of a plastron formed of numerous small bones and of uncinæ processes to the ribs (as in Birds and Crocodiles).

### Order III. LACERTILIA, OR LIZARDS.

[Cases  
10-17.]

The Order of Lizards comprises over 1900 species, which exhibit a great variety of form and structure. Some, like our common Lizards, possess four legs and a long tail, and are endowed with great rapidity of motion; others, like the Chamæleons, are arboreal, and have their limbs and tail adapted for climbing on the branches of trees; others, like the Geckos, can ascend smooth vertical surfaces, their toes being provided with special adhesive organs. The limbs may be rudimentary or disappear entirely, as in our common Slowworm, in which case the Lizard assumes the appearance of a Snake; but, in all, rudiments at least of both pectoral and pelvic bones are hidden under the skin. Lizards

Fig. 2.



Hind legs of Lizards, to show the gradual abortion.

a, *Chalcides ocellatus*; b, *Chalcides mionecton*; c, *Chalcides tridactylus*;  
d, *Lygosoma lineo-punctulatum*; e, *Chalcides guentheri*.

may be characterized as Reptiles with the skin covered with scales or tubercles ; with non-expandible mouth, the rami of the mandible being firmly united anteriorly by a suture ; with four or two limbs, or at least rudiments of pectoral and pelvic bones ; with teeth which are ankylosed to the jaws, and not implanted in sockets ; with a transverse anal opening. Movable eyelids and an ear-opening are usually present. If the limbs are developed, they are generally provided with five digits armed with claws ; but as in some kinds the limbs get weaker and shorter, the number of toes is gradually reduced ; and there are Lizards in which the little limb terminates in a single useless toe, or is even entirely toeless (see Fig. 2). The *tongue* offers very remarkable differences in form and function. It is simple, broad, short, soft in the Geckos, Agamas, and Iguanas, and is probably an organ of taste ; in the majority of the other families it is narrow, more or less elongate, often covered with scale-like papillæ, and with a more or less deep incision in front, assuming more and more the function of an organ of touch. It is of extraordinary length, worm-like, and terminating in two fine, long points in the Monitors, in which, as in Snakes, it acts as a feeler only. The tongue of the Chamæleons will be noticed subsequently.

Lizards are spread over the whole world except the very cold regions, and are, like all other Reptiles, most numerous, both as regards species and individuals, between the tropics. They are divided into many families, some of which can be alluded to here by name only :—

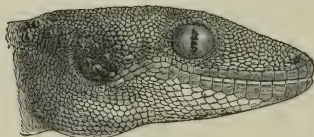
Families—1. *Geckonidæ*. 2. *Eublepharidæ*. 3. *Uroplatidæ*. 4. *Pygopodidæ*. 5. *Agamidæ*. 6. *Iguanidæ*. 7. *Xenosauridæ*. 8. *Zonuridæ*. 9. *Anguidæ*. 10. *Anniellidæ*. 11. *Helodermatidæ*. 12. *Varanidæ*. 13. *Xantusiidæ*. 14. *Teiidæ*. 15. *Amphisbænidæ*. 16. *Lacertidæ*. 17. *Gerrhosauridæ*. 18. *Scincidæ*. 19. *Anelytropidæ*. 20. *Dibamidæ*.

The last family, the *Chamæleontidæ*, is so distinct from all the others that some herpetologists would remove it from the Lacertilia altogether.

The majority of Lizards, especially the smaller kinds, are not suitable objects for exhibition in a dry state ; they must be preserved in spirit ; consequently only a selected series is exhibited in this Gallery.

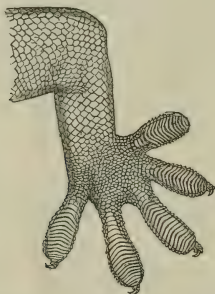
[Case 10.] The *Geckonidæ*, or Geckos, are Lizards of small size, the largest measuring about a foot, and have always attracted attention by their possessing the faculty of ascending smooth surfaces, or even of running on the ceilings of rooms like a fly. For this purpose the

Fig. 3.

Head of *Gecko verticillatus* (East Indies).

lower surface of their toes is provided with a series of movable plates or disks, by the aid of which they adhere to the surface over which they pass. Geckos are found in almost every part of the globe between and near the tropics, frequenting houses, rocks, and trees.

Fig. 4.

Hind leg of *Gecko verticillatus*.

With few exceptions they are nocturnal, and consequently large-eyed, animals, the pupil being generally contracted in a vertical direction. Geckos are extremely useful in destroying insects, and, though greatly feared by those not acquainted with their habits, are perfectly harmless. Nearly all Geckos possess a voice; and the large *Gecko verticillatus*, which is extremely common in the East-Indian Archipelago, utters a shrill cry, sounding like "tokee" or "tock."



The *Varanidæ*, or Water Lizards, are the largest of Lizards, some exceeding a length of six feet. A few (*Varanus griseus*, Case 11) are terrestrial, but the majority semi-aquatic, the former having a rounded, the latter a compressed tail, with a sharp saw-like upper edge, which assists them greatly in swimming, and at the same time constitutes a formidable weapon with which these powerful animals can inflict deep wounds on the incautious captor. They range all over Africa, the Indian region, and Australia. Their prey consists of other vertebrate animals—small mammals, birds, frogs, fishes, and eggs. In India they are well known under the misnomer “Iguanas” as dangerous neighbours to poultry-yards. Among the species which grow to the largest size may be mentioned the gigantic Monitor (*Varanus giganteus*, Case 16), from N. Australia; the two-streaked Monitor (*V. salvator*, Cases 15–17), common in the East-Indian Archipelago; the common Indian Water-Lizard (*V. bengalensis*); and the African Monitor (*V. niloticus*), ranging over the whole of Tropical Africa (Case 14). [Cases 15–17.]

The *Helodermatidæ* contain a single genus, the remarkable *Heloderma*, of which two species are known (*H. horridum* and *suspectum*), inhabitants of Arizona and the western parts of Mexico. So far as is known at present, they are the only Lizards whose bite is poisonous. Their teeth are fang-like, provided with a deep groove as in some Snakes, and the submaxillary gland is enormously developed and secretes the poisonous fluid. They are about two feet long. [Case 14.]

The *Tejidæ* (Case 13) are the American representatives of the Lizards proper, from which they somewhat differ in their dentition. The Teguxins (*Tupinambis teguexim* and *nigropunctatus*) are the largest, attaining to a length of about four feet, and found in most parts of the South-American continent. The *Dracæna guianensis* is a rare Lizard, found in the Guianas and Brazil, and was considered a kind of Crocodile by old authors, who saw a distinct resemblance to those animals in its compressed, keeled tail, as well as in the large tubercles which are arranged pretty regularly on its back. [Case 13.]

Of the *Amphisbænidæ*, singular worm-like Reptiles, a few specimens and a skeleton are exhibited. All their external characters testify to their mode of life; they are burrowing animals, [Case 14.]

passing the whole of their existence under ground in loose soil, sand, or ant-heaps. The skin is not protected by either scales or scutes, but divided by circular and longitudinal folds into quadrangular segments arranged in rings. The colour of the skin is either whitish, reddish, or greyish, sometimes marbled with black. Legs are absent (with the exception of the genus *Chirotes*, in which a pair of very short fore legs are developed). The head and tail are both short; and the superficial similarity of the two extremities in some of the species has led to the belief that they could progress backwards and forwards with equal facility; they are often described as "Two-headed Snakes." Their eyes are quite rudimentary, hidden below the skin; ear-openings are likewise absent. The Amphisbænians are inhabitants of hot countries—Africa, America, and the countries round the Mediterranean. About 50 different species are known.

[Case 14.] Lizards proper (*Lacertidæ*) are confined to the Old World, and found in Europe, Asia, and Africa. They seldom reach a length of eighteen inches (*Lacerta ocellata*); they feed on small animals, insects and worms being the principal diet, but a few, like the small Lizards of Madeira, have taken to a vegetable diet, and cause some injury to grapes and other soft fruit. The Common British Lizard is *Lacerta vivipara*; the Sand Lizard (*L. agilis*) and Green Lizard (*L. viridis*) being more locally distributed in the Southern Counties and the Channel Islands, but very abundant in various parts of the continent of Europe.

[Case 14.] The *Anguidæ* include limbed as well as limbless forms; of the latter the Slowworm or Blindworm (*Anguis fragilis*), common in Great Britain, is the best known. The Glass Snake, or Sheltopusik (*Pseudopus pallasii* or *Ophisaurus opus*), common in South-eastern Europe and Western Asia, is another example.

[Case 14.] The *Scincidæ* or Skinks, recognizable by their round imbricate scales, also include forms in which the limbs are rudimentary or absent. The largest forms of this family are Australian, as *Tiliqua gigas* and *nigrolutea*, and *Trachydosaurus*, the last remarkable for their rough scales and short tail, somewhat resembling the cone of a fir-tree. A very curiously shaped form, also from Australia, is *Egernia stokesii*, with its short conical tail armed with dagger-pointed spinous scales.



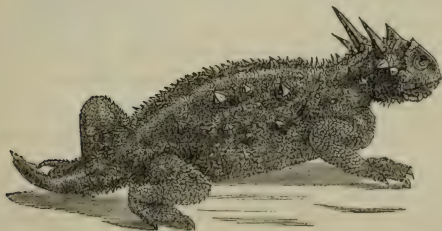
The *Iguanidæ* are American pleurodont Lizards (see Fig. 7) exhibiting an astonishing variety of form. The largest and best known are the Iguanas (*Iguana rhinolophus* and *tuberculata*, Case 12), found [Cases 11-13.]

Fig. 5.

*Iguana tuberculata* (Brazil).

in the forest-regions of Tropical America only, in the neighbourhood of water, into which when frightened they jump from the overhanging branches of trees, to escape capture by swimming and diving. Feeding exclusively on leaves or fruits, they are themselves highly esteemed as food, and their eggs also are eagerly sought for by the natives. Iguanas grow to a length of five feet. The marine Iguana (*Amblyrhynchus cristatus*, Case 13) is an inhabitant of the Galapagos Islands, living on the rocks of the shore and feeding on seaweeds. No other Lizard enters sea-water. Among the smaller representatives of this large family may be mentioned the *Anolis*, extremely numerous in Tropical America and the West Indies—small, slender, agile, thoroughly arboreal Lizards, of rare beauty

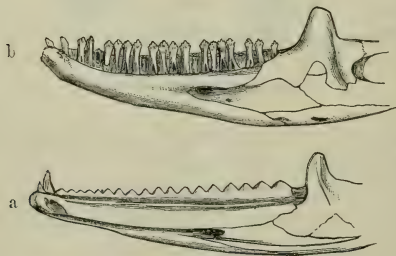
Fig. 6.

Californian "Toad" (*Phrynosoma cornutum*).

and variety of colour, and forming a striking contrast to the species of *Phrynosoma* (Case 11) of North America and Mexico, which, on account of their shape and sluggish habits, have earned the name of Horned or Californian Toads (fig. 6).

[Case 10.] The *Agamidæ* represent the Iguanas in the Old World. They are distinguished by the acrodont dentition, the teeth being ankylosed to the upper edge of the jaws, an arrangement which occurs

Fig. 7.



Lower jaws, showing the acrodont (*a*) and pleurodont (*b*) dentition.

also in the Rhynchocephalians, some Amphisbænians, and the Chamæleons. Lizards of this family are most abundant in the Indian and Australian regions, showing a great variation of form analogous to that of the preceding family. The perhaps most highly specialized Agamoid is the genus *Draco*, small winged Lizards from the East Indies (fig. 8). The Dragons are tree-lizards, and possess a peculiar additional apparatus for locomotion: the much-prolonged five or six hind ribs are connected by a broad expansive fold of the skin, the whole forming a subsemicircular wing on each side of the body, by which they are enabled to take long flying leaps from branch to branch, and which are laid backwards at the sides of the animal while it is sitting or merely running.

The Frilled Lizard (*Chlamydosaurus kingii*, fig. 9) is an Australian Agamoid, growing to a length of two feet. It is provided with a frill-like fold of the skin round the neck, which, when erected,

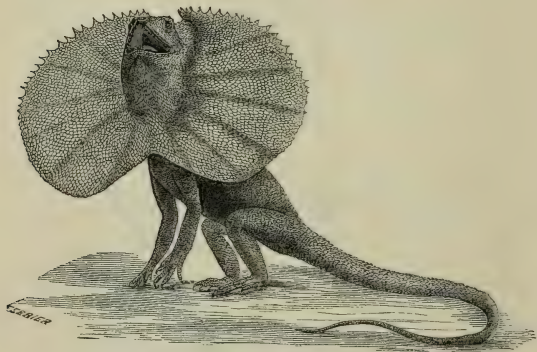
Fig. 8.



Dragon (*Draco teneiopterus*); Siam.

resembles a broad collar, not unlike the gigantic lace-ruffs of Queen Elizabeth's time. When startled, this Lizard rises with the fore legs off the ground, and runs with semi-erect body supported by the

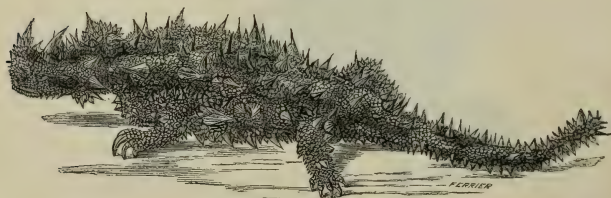
Fig. 9.



Frilled Lizard from Australia (*Chlamydosaurus kingii*).

hind limbs only. An extraordinary creature is the Moloch (*Moloch horridus*), also from Australia; the tubercles and spines, with which it is entirely covered, give it a most repulsive appearance;

Fig. 10.



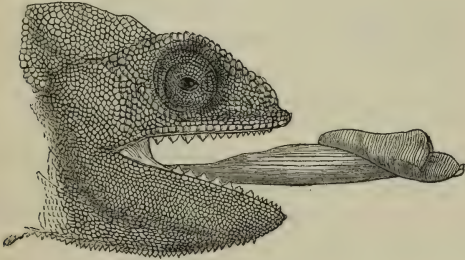
*Moloch horridus* (Australia).

but it is perfectly harmless. Other Lizards of this family are the Australian *Amphibolurus* and the African and Asiatic *Uromastix*.

[Case 10.] The *Chamæleontidæ*, or Chamæleons, are almost peculiar to Africa, and most numerous in Madagascar; one species extends into India. No other member of the Order of Lizards shows

such a degree of specialization as the Chamæleon. The tongue, eyes, limbs, tail, skin, lungs are modified in a most extraordinary manner to serve special functions in the peculiar economy of these animals. They lead an exclusively arboreal life: each of their feet is converted into a grasping hand, by means of which,

Fig. 11.



Common Chamæleon.

assisted by a long prehensile tail, they hold to a branch on which they are sitting, so fast that they can be dislodged only with difficulty. Their movements are slow and awkward on the

Fig. 12.



Hand of Chamæleon.

ground, and still more so in the water, where they are nearly helpless. The tongue (fig. 11) is exceedingly long, worm-like, with a club-shaped viscous end; they shoot it out with incredible rapidity towards insects, which remain attached to it, and are thus caught. The eyes are almost entirely covered by a thick lid, pierced with a small central hole, and not only can be moved in any direc-

tion, but each has an action independent of the other—one eye may be looking forwards, whilst an object behind the animal is examined with the other. The faculty of changing colour, which they have in common with many other Lizards, is partly dependent on the degree in which the lungs are filled with air, and different layers of chromatophores\* are pressed towards the outer surface of the skin. The adult males of some of the species possess long horns or other excrescences on the head. The largest species attain a length of 18 and 20 inches. About 75 species are known.

#### Order IV. OPHIDIA, or SNAKES.

[Cases  
18-22.]

The Snakes, or Ophidians, are scaly Reptiles, with exceedingly elongate, limbless body, without sternum, without, or with only rudiments of, a pelvis, with the mandibles united in front by an elastic ligament. The ribs are articulated movably with the vertebral column. The jaws are armed with sharp, fang-like teeth, which are ankylosed to the bone. The peculiar mobility of the jaw-bones enables these animals to extend the gape in an extraordinary degree, and to work their prey (which generally is much thicker than the Snake itself and always swallowed whole) through the throat into the stomach. The tongue is narrow, retractile into a basal sheath, and terminates in two long thread-like points; it is frequently and rapidly exerted when the animal is excited or wants to touch an object. Snakes have no eyelids; but the part of the epidermis which covers the eye is transparent, convex, and has the shape of a watch-glass, behind which the eye moves. There is no ear-opening. The scales are not isolated formations, as in fishes, but merely folds of the outer skin, which is cast off in a single piece several times every year. The head is generally covered with large, symmetrical, juxtaposed plates (see figs. 15 & 16), and the belly with large transverse shields. The organs of locomotion for the exceedingly elongate body of the Snakes are the ribs, the number of which is very great, nearly corresponding to that of the vertebræ of the trunk. Although the motions of Snakes are in general very quick, and may be adapted to every variation of

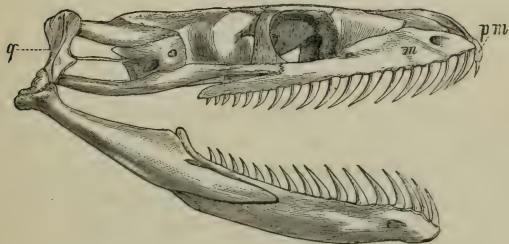
\* Cells in the skin in which the colouring-pigment is deposited.



ground over which they move, yet all the varieties of their locomotion are founded on the following simple process. When a part of their body has found some projection of the ground which affords it a point of support, the ribs, alternately of one and the other side, are drawn more closely together, thereby producing alternate bends of the body on the corresponding side. The hinder portion of the body being drawn after, some part of it finds another support on the rough ground or a projection, and the anterior bends being stretched in a straight line, the front part of the body is propelled in consequence. During this peculiar kind of locomotion, the numerous broad shields of the belly are of great advantage, as, by means of the free edges of those shields, they are enabled to catch the smallest projections on the ground, which may be used as points of support. Snakes are not able to move over a perfectly smooth surface.

*Non-venomous* Snakes have generally two rows of short, thin

Fig. 13.



Skull of Snake (Python).

*m*, maxillary ; *pm*, premaxillary ; *q*, quadrate bone.

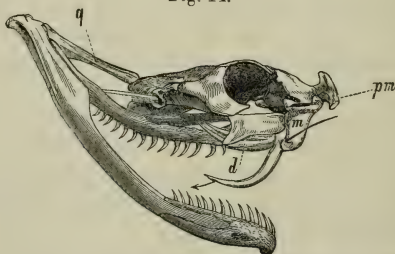
teeth, pointed like a needle, on each side of the upper jaw, and one in the lower ; sometimes one or two of the anterior teeth are longer than the rest, but they are not grooved or perforated, nor do they communicate with a poison-gland. Other species have one or more of the hindmost maxillary teeth enlarged, and provided with a longitudinal groove. The Snakes with such long grooved posterior teeth are provided with a small poison-gland and possess slight poisonous properties, paralyzing their



prey before deglutition; but the simple bite of these Snakes is harmless.

The truly *poisonous* Snakes are armed with a long grooved or canaliculated tooth in front of the upper jaw; the channel terminates at the extremity, and is in connection with a duct which carries

Fig. 14.

Skull of Poisonous Snake (*Bitis nasicornis*).

*m*, maxillary, with poison-fang; a bristle is inserted in the openings of the channel at the base and point of the tooth; *d*, undeveloped poison-fangs; *pm*, premaxillary; *q*, quadrate bone.

the poisonous fluid from a large gland to the tooth. This venom-gland is situated on the side of the head, above the angle of the mouth, and invested by a dense fibrous sheath, which is covered by a layer of muscular fibres. At the moment the Snake opens its mouth to bite, the muscles compress the gland, and force its contents through the excretory duct into the channel of the venom-tooth, whence it is ejected into the wound. The force with which the gland is compressed is shown by the fact that irritated animals have been seen to spout the poison from the aperture of the tooth to a considerable distance. The venom-apparatus serves these creatures not only for defence, but also, and chiefly, for the purpose of overpowering their prey, which is always killed before they commence to swallow it.

The dental apparatus is not the same in all poisonous Snakes. The venom-tooth is always fixed to the maxillary bone; but in some this bone is as long, or nearly as long, as in the non-venomous Snakes, and generally bears one or more ordinary teeth on its hinder portion. This venom-tooth is always more or less erect,

not very long, and its channel generally visible as an external groove. Poisonous Snakes with such a dentition resemble also in other respects the non-venomous Serpents, and are designated as *Venomous Colubrine Snakes*.

In the other venomous Snakes the maxillary bone is extremely short, and does not bear any ordinary teeth, only an exceedingly long curved fang, perforated in its entire length. Although this tooth also is fixed to the bone, the bone itself is very mobile; so that the tooth, which is laid backwards when at rest, can be erected the moment the animal prepares to strike. The tooth is occasionally lost; but others, in different stages of development, lie in the gum behind it, ready to take the place of the lost tooth.

Most Snakes feed on living animals, a few only on eggs. They are oviparous or ovoviviparous. They number about 1600 species, and are spread over all temperate regions, but are most numerous between the tropics. They are absent in New Zealand. The Order is divided into 9 Families and numerous minor groups.

- Fam. 1. *Typhlopidae*. } Burrowing, blind Snakes.  
 „ 2. *Glauconiidae*. }  
 „ 3. *Boidæ*, with two Subfamilies:—*Boinæ*, Boas and Eryces,  
 and *Pythoninæ*, Pythons.  
 „ 4. *Ilysiidæ*.  
 „ 5. *Uropeltidæ*, or Earth-Snakes.  
 „ 6. *Xenopeltidæ*.  
 „ 7. *Colubridæ*, with 8 Subfamilies:—*Acrochordinæ*, *Colubrinæ*,  
*Dasypeltinæ*, *Homalopsinæ*, *Dipsadomorphinæ*, *Elachistodontinæ*, *Hydrophiinæ*, *Elapinæ*.  
 „ 8. *Amblycephalidæ*.  
 „ 9. *Viperidæ*, with two Subfamilies:—*Viperinæ*, Vipers  
 proper, and *Crotalinæ*, Pit-Vipers.

Snakes are most unsuitable objects for preservation in a dry state, as no method is known by which the singularly regular arrangement of their scales, and their sometimes beautiful coloration and lustre, can be preserved. Therefore only a small proportion of the collection is exhibited, of which the following deserve particular notice:—

The Burrowing or Blind Snakes (*Typhlopidae* and *Glauconiidae*) are small worm-like species, with teeth in one of the jaws only, and without enlarged ventral plates. They are numerous in Africa and India, though occurring also in tropical America and Australia; one species is found in South-eastern Europe.

[Cases  
18-20.]

The *Pythoninae*, or Rock Snakes, are found in the hottest parts of Africa, Asia, and Australia, and attain a very large size (from 8 to 24 feet). They climb as well as swim, most of them preferring the neighbourhood of water. Like the Boas, to which they are closely related, and from which they differ chiefly in the presence of intermaxillary teeth, they overpower their prey by constriction. The Pythons of Africa, Asia, and of Australia represent this family.

The *Boinae*, or Boas and Eryces, are mostly from the tropical parts of the New World. The Anaconda (*Eunectes murinus*), which grows to 30 feet, is the largest Snake known, the true *Boa constrictor* being a much smaller species (Case 24).

[Case 21.]

The *Colubridae* form the great bulk of the Order, and are found in every part of the temperate and tropical regions, but

Fig. 15.



Smooth Snake (*Coronella  
lævis*).

Fig. 16.

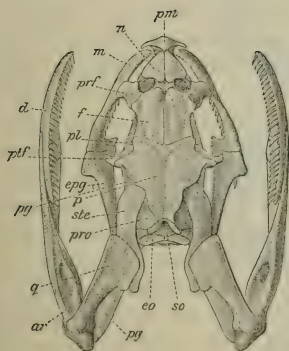
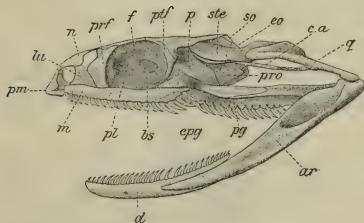


Common Snake (*Tropidonotus  
natrix*).

are only scantily represented in the islands of the Pacific. To the group *Colubrinae* belong the Smooth Snake (*Coronella lævis*),

found in the southern parts of England, and the Common or Ringed Snake (*Tropidonotus natrix*). The Tree- or Whip-

Fig. 17.



Skull of Common Snake (*Tropidonotus natrix*).

an. Angular.	f. Frontal.	pro. Prootic.
ar. Articular.	m. Maxillary.	pg. Pterygoid.
bo. Basioccipital.	n. Nasal.	ptf. Postfrontal.
bs. Basisphenoid.	p. Parietal.	q. Quadrate.
ca. Columella auris.	pl. Palatine.	so. Supraoccipital.
a. Dentary.	pm. Præmaxillary.	ste. Supratemporal.
eo. Exoccipital.	prf. Præfrontal.	v. Vomer.
epg. Ectopterygoid.		

Snakes are exceedingly slender and elongate, and some are exquisitely coloured, green being the predominant hue. They

feed chiefly on tree-lizards and birds, and are found in all the tropical regions.

The Freshwater Snakes (*Homalopsinæ*) are thoroughly aquatic, several of them even entering the sea. In some points of their organization they approach the truly marine *Hydrophiinæ*. They feed on fish, and belong chiefly to the Indian region.

[Case 20.]

The *Acrochordinæ* are distinguished by their small, wart-like, not imbricate, tubercular or spiny scales. *Acrochordus javanicus*, from Java, Borneo, and the Malayan peninsula, grows to a length of 8 feet.

[Case 21.]

The *Elapinæ* are poisonous Snakes, with the physiognomy of the harmless Colubrine Snakes: they occur in all the tropical regions, and are most abundant in species in Australia, where they form almost the entire Snake-fauna. The Indian Cobra (*Naja tripudians*) and the African Cobra (*Naja haje*) are two of the best known and most dreaded Ophidians. They possess the remarkable faculty of expanding their neck when irritated, by raising the elongated ribs of this region, and thus stretching the skin outwards on each side; the dilatable portion is frequently ornamented on the back by a figure resembling a pair of spectacles. The Hamadryad, *Ophiophagus elaps*, or *Naja bungarus*, is allied to the Cobra, but attains to a much larger size, and is one of the most dangerous venomous Snakes, as it is well known to frequently attack people without provocation. It feeds on other Snakes, and occurs in many parts of the Indian continent and archipelago. A specimen, 13 feet long, is exhibited in a spirit-tank opposite the wall-case. The true *Elaps*, or Coral-Snakes, are small, brilliantly-coloured Snakes, and their very small mouth renders them much less dangerous to man.

[Case 21.]

The Sea-Snakes, *Hydrophiinæ*, are inhabitants of the tropical parts of the Indian and Pacific Oceans, and most abundant in the East-Indian archipelago and in the seas between Southern China and North Australia. They pass their whole life in the sea. Their tail, which is compressed and paddle-shaped, answers all the purposes of the same organ in a fish, and their motions in the water are almost as rapid as they are uncertain and awkward on land. These Snakes are highly poisonous; their dentition resembling

that of the preceding family. Their food consists entirely of fish. The greatest size to which some species attain is about 12 feet. *Pelamys bicolor* and *Hydrophis* are examples of this family.

Fig. 18.



Sea-Snake (*Hydrophis*), from the Indian Ocean.

The Vipers (*Viperinæ*) and Rattlesnakes (*Crotalinæ*) are Snakes [Case 22.] with the most perfect poison-apparatus; the latter subfamily being distinguished from the former by the presence of a deep pit on the side of the snout, between the eye and the nostril. These Snakes have generally a short thick body and a broad head, are slow in their movements, and nocturnal; some live on bushes,



most of them on the ground. They are viviparous. The true Vipers are chiefly African, a few species only occurring in Europe and Asia. The common British Viper is one of the smallest of

Fig. 19.

Common Viper (*Vipera berus*).

this group; the Puff-Adder (*Bitis arietans*), the most dangerous Snake of South Africa.

The Pit-Vipers and Rattlesnakes are found only in Asia and America, most abundant and reaching a larger size in the latter part of the world. The true Rattlesnakes (*Crotalus*) are distinguished by the "rattle" at the end of the tail, formed by several horny rings, which the animal shakes when irritated, producing a peculiar sound. It is stated that the length of the "rattle" indicates the age of the individual; and it is a fact that rattles of such a length and so many joints (twenty-one), as are exhibited in Case 22, are now of extremely rare occurrence, as these dangerous creatures, with the advance of cultivation, have now but rarely the chance of surviving to a very old age.

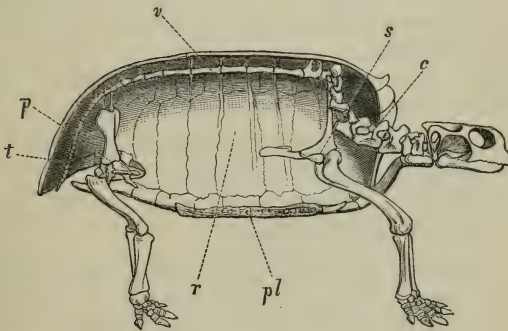
#### Order V. CHELONIA (TORTOISES and TURTLES).

The Chelonians, or Tortoises and Turtles, are distinguished from all other Reptiles by the more or less ossified case or "shell"



which encloses the body, and into which most of the species can retract their head and limbs. This armour consists of two shields united by their lateral margins; the upper, or carapace, is formed by the expansion and union of the vertebræ and ribs; the lower, or plastron, by dermal bones only. In most of these animals the carapace presents three series of central bony plates—the vertebral medially, and the costal laterally—and they are surrounded by a series

Fig. 20.



Skeleton of Tortoise, in a vertical section through the carapace.

*c*, neck; *v*, dorsal vertebræ; *t*, tail; *r*, costal plates; *pl*, plastron;  
*s*, shoulder-bones; *p*, pelvis.

of marginal plates; the plastron bones are generally nine in number, one median and four pairs. Horny epidermic plates cover the carapace and plastron; their arrangement is also symmetrical, but by no means corresponds to that of the underlying bones; they constitute what is called the "Tortoise-shell," which in some species has great commercial value. The jaws are toothless, covered by a horny bill, rarely hidden under fleshy lips. The four limbs are always well developed, and modified according to the mode of life of the species,—the terrestrial Tortoises having short, club-shaped feet furnished with blunt claws; the freshwater

Turtles, digits distinct, armed with sharp claws, and united by a more or less developed membrane or web; and, finally, the marine Turtles, having their limbs transformed into regular paddles, resembling those of Cetaceans. The tail is constantly present, but frequently extremely short; in a few forms only it attains to a considerable length. Chelonians are oviparous, and the eggs are generally covered with a hard shell.

The Chelonians form only a small part of the Class Reptilia, the number of species amounting to about 300. If they occupy in this Gallery almost half of the wall-cases, it is because they are more suited than the other Reptiles for being preserved and exhibited in a dried state.

Chelonians may be divided according to their mode of life into the following Groups:—

*Sphargidæ* and *Cheloniidæ*, or Sea-Turtles.

*Trionychidæ*, or Freshwater Turtles.

*Emydidæ* and *Chelydidæ*, or Freshwater Tortoises.

*Testudinidæ*, or Land Tortoises.

The *Sphargidæ* are a geologically ancient type, in which the formation of a protecting bony carapace has made but little advance. The skin, which in a fresh state is flexible, like thick leather, contains bony deposits arranged like mosaic; but this dermal shield is not united to the vertebræ and ribs, which remain free, and are not particularly dilated, as may be seen in the large skeleton (G) exhibited opposite to Case 29. In this arrangement the dermal shield and skeleton are in the same relation to each other as in the Crocodiles. The shape of the limbs is the same as in the marine Turtles, with which the Leather-Turtle agrees in its mode of life; the bones of the paddles, however, have different proportions, they are still more simple, merely rods, and claws are entirely absent. Only one species exists in our time (*Dermochelys coriacea*), which seems to become gradually rarer, although it is found occasionally throughout all the seas of the tropical and temperate regions, specimens having strayed now and then to the British coast. This Turtle is, perhaps, the largest living Chelonian, exceeding a length of 6 feet, and is said to be herbivorous.

*Cheloniidæ* or true Marine Turtles. Their feet are transformed into long compressed fins, the anterior pair considerably longer than the posterior, the digits being enclosed in a common skin, out of which only one or two claws project; the carapace is broad and much depressed, but large interspaces between the extremities of the ribs remain unossified; it is covered with symmetrical horny plates. These Turtles are thoroughly marine animals, their fin-like feet and their light shell rendering them the best swimmers in the class of Reptiles. They sometimes live hundreds of miles distant from the shore, to which, however, they periodically return in order to deposit from 100 to 250 soft-shelled eggs, which are buried in the sand. The food of some species (*Chelone mydas*) consists exclusively of algæ; others (*Thalassochelys*) subsist upon fish and mollusca. They are found in all the intertropical seas, but sometimes they travel far into the temperate regions, specimens being occasionally captured on the British coasts. The flesh and eggs of all the species are edible, the Green Turtle (*Chelone mydas*) being the most esteemed. The Hawk's-bill Turtle (*Chelone imbricata*) furnishes the commercial tortoise-shell; the finest sort comes from Celebes, whence it is exported to China. Specimens of polished shell from the Indian Ocean and Jamaica are exhibited. A common Atlantic species is the Loggerhead Turtle (*Thalassochelys caretta*), which forms an exception to all other recent Chelonians in having five instead of four epidermic plates on the side (costals).

[Cases  
23, 29, 30.]

The *Trionychidæ* are Freshwater Turtles, with much depressed shell, which is covered with soft skin, and not with epidermic plates; the digits are movable, strongly webbed, and each foot has only three sharp claws, belonging to the three inner digits, exactly as in Crocodiles. The jaws are covered with fleshy lips, and the snout is produced in a short tube bearing the nasal orifices, and enabling the animal to breathe while the rest of the head is submerged under water. These animals are thoroughly aquatic and carnivorous, and inhabit the hotter parts of Asia, Africa, and North America. We may note the Javanese and Gangetic Trionyx (*Trionyx javanicus* and *gangeticus*), and the Nilotic Trionyx (*T. triunguis*), as showing the largest size attained by these Turtles.

[Cases  
23-25.]

[Cases  
31-38.]

The *Emydidæ*, or Freshwater Tortoises, possess a perfectly ossified carapace covered with epidermoid plates, and movable digits furnished with sharp claws. The mode of life of some is aquatic, of others almost terrestrial; the former having their shell least convex, and a more or less developed web between the toes. Thoroughly aquatic are the Alligator Terrapens of North America (*Chelydra* and *Macrochelymys*, Case 31), in which the tail attains to a great length, and is furnished with a crest resembling that of a Crocodile; *Macrochelymys temminckii* is the largest freshwater Tortoise. The East-Indian *Batagur* (Case 33) approach in their physiognomy and habits and in size the Freshwater Turtles. The smaller forms are most abundant in North America, and sometimes beautifully marked (*Clemmys picta*, *rivulata*, *ornata*, &c., Case 36). The European species (*Emys orbicularis*, Case 36) is abundant in South Europe, and found, less frequently and locally, in Germany as far north as Berlin; its fossil remains have been found in the fen-country. *Nicoria*, *Geogemyda*, *Cyclemys* live as much on land as in water; and, finally, we have an example of an exclusively terrestrial Emydoid in the Box-Tortoise (*Cistudo carolina*, Case 38), which lives in the woods of the eastern and southern parts of the United States, and possesses, like *Emys*, hinges in the lower shield, rendering its anterior and posterior portions movable. A lid is thus formed by which the openings of the shell can be completely closed.

The following Freshwater Tortoises differ from the preceding in not being able to retract the head and neck, but in bending it sideways under the shell, as the American *Podocnemys expansa* (Case 26, 27), of which a fine skeleton is exhibited, and the Australian *Chelodina*. But the most remarkable form of this group is the Mata-Mata Tortoise (*Chelys fimbriata*, Case 26), a native of Brazil and the Guianas. Its head and neck are fringed with warty appendages, floating in the water like some vegetable growth, whilst the rough, bossed carapace resembles a stone,—an appearance which evidently is of as great use to this creature in escaping the observation of its enemies as in alluring to it unsuspecting animals on which it feeds.

[Cases  
39-44.]

The *Testudinidæ*, or Land Tortoises, have a very convex carapace, and feet adapted for progression on land only. They are

Fig. 21.

The Mata-Mata (*Chelys fimbriata*); British Guiana.

vegetable-feeders, and inhabit the hotter parts of the Old as well as New World, but are absent in Australia. The greater part are referable to the genus *Testudo*, of which one species occurs in Southern Europe (*Testudo græca*, Case 42); another closely allied species is *T. ibera*, extremely abundant in Morocco and Algiers, and imported in great numbers into England. But the most interesting forms of this group are the Gigantic Tortoises (Cases 39–41), which were formerly found in great numbers in the Mascarene and Galapagos islands. At the time of their discovery these islands were uninhabited by man or any large mammal; the Tortoises therefore enjoyed perfect security, and this, as well as their extraordinary degree of longevity, accounts for their enormous size and the multitude of their numbers. They could be captured in any number with the greatest ease within a few days, and proved to be a most welcome addition to the stock of provisions. They could be carried in the hold of a ship, without food, for months, and were slaughtered as occasion required, each Tortoise yielding, according to size, from 80 to 100 pounds of excellent and wholesome meat. Under these circumstances, the numbers of these helpless creatures decreased so rapidly, that in the beginning of this century their extermination was accomplished in the Mascarenes; and now only a few remain in a wild state in Aldabra and some of the islands of the Galapagos group. We may note particularly the gigantic Land Tortoise of Aldaba (*Testudo elephantina*); the large male specimen (H) exhibited weighed 870 pounds, and although known to have been more than 80 years



old, was still growing at the time of its death; the gigantic Land Tortoise of Abingdon Island (*T. abingdonii*), remarkable for its

Fig. 22.



*Testudo abingdonii*. The Tortoise of Abingdon Isl., Galapagos.

long neck and its thin shell, which may be easily pierced by a knife. The specimens exhibited were obtained by Commander W. E. Cookson during the visit of H.M.S. 'Petrel' to the Galapagos Islands in 1875, and were probably the last survivors of their race.



## BATRACHIANS.

(FROGS AND NEWTS.)

---

### GENERAL NOTES.

A TABLE-CASE placed in the passage leading from the Bird- to the Fish-Gallery contains a small series of this class of animals. The softness of their skin prevents their being preserved in a dry condition; therefore of the thousand species known only a few typical specimens are exhibited.

Although *Batrachia* are popularly regarded as Reptiles, they have much in common with Fishes, from which it is by no means easy to separate them.

They may be defined as cold-blooded \* Vertebrata, the majority of which have a pair of lungs which lie below the digestive tract, which for some, or the whole, period of their existence breathe by gills, have three chambers to the heart, and two or no occipital condyles; their limbs, if present, have not more than five fingers developed, and if, as is rare, they possess dorsal fins, these are merely folds of the integuments without those supporting cartilaginous or bony rays which are found in Fishes.

The skin is soft, moist, richly provided with blood; small scales with rounded edges are found only in some of the Limbless forms.

In the majority of Batrachians the young when it leaves the egg is totally unlike, and afterwards gradually changes into, the form and condition of the perfect animal. This change is called "metamorphosis." The young or larva is fish-like and breathes by gills,

\* See page 1 with regard to this term.

which are gradually exchanged for lungs ; in some Batrachians in which the larva is to some extent a vegetable-feeder, the change from mixed to an exclusively animal diet is accompanied by a shortening of the intestine ; and in many the loss of a tail is compensated by the growth of four limbs, whilst in others the tail is persistent throughout life. The metamorphosis is very complete in Frogs and Toads, in which the limbless, long-tailed larva or 'Tadpole' differs so much from the perfect animal that only direct observation can afford the proof of these changes being the developmental stages of the same creature. However, a few Tailed Batrachians (*Proteidæ*, *Sirenidæ*) retain the gills throughout their existence, though producing one or two pairs of limbs ; and a certain number of Frogs belonging to various genera (*Rana*, *Hylodes*, *Rhinoderma*, *Pipa*, &c.) are known to leave the egg in the perfect form.

The greater number of Batrachians are oviparous ; some, like the Salamander, are ovoviviparous. The eggs are deposited in water or damp places, and generally (in all the British species) enveloped in a gelatinous capsule, which protects them from mechanical injury and atmospheric influences : those of the Frogs form large coherent lumps, whilst the Toads deposit theirs in long strings, and the Newts attach theirs singly to water-plants. In a few species the *female* carries the eggs in a pouch on her back (*Nototrema*), or in dorsal cells (*Pipa*), or attached to her belly (some *Rhacophori*) ; in a few the *male* carries the eggs round his legs (*Alytes*) or in a gular sac (*Rhinoderma*).

The tongue is occasionally absent ; when present it is generally attached to the front end of the floor of the mouth instead of, as in the higher Vertebrates, at the hinder end ; in the majority of the Tailless Batrachians it can be thrust out of the mouth, and act as the organ with which they seize their prey. (See fig. 25, p. 37.)

In many species a sac or a pair of sacs are developed on the throat or the side of the head in the males ; they act as resonants to the waves of sound set up by the air which is passing from the lungs, and the species that possess them are much more noisy than those that are without them.

All Batrachians have numerous small glands imbedded in their skin for the secretion of a whitish slimy fluid. In some these glands

are more developed than in others, and when many are placed close together they form protuberant masses, sometimes on each side of the neck (parotoids of Toads and Salamanders), sometimes on the loin or on the hind legs, or on other parts of the body. There is no doubt that in most species this secretion has more or less poisonous properties; that of the Common Toad is sufficiently disagreeable to dogs, birds of prey, &c. to act as a protection to the Batrachian; but that of some South-American species of the genus *Dendrobates* is said to be a much more active poison, and to be used by the Indians as one of the ingredients of their arrow-poison.

All the Batrachians which flourished in the older formations, Carboniferous to Trias inclusively, belonged to the extinct order *Stegocephala* or *Labyrinthodonta*, and were succeeded in the Cretaceous by the Tailed, in the Tertiary by the Tailless Batrachians, which order appears to have now attained its highest point of development. No fossil Cœcilian has as yet been found.

Recent Batrachians are referable to three orders, viz.:—

1. *Ecaudata*, Tailless Batrachians, such as Frogs and Toads;
2. *Caudata*, Tailed Batrachians, such as Salamanders, Newts, and Permanent Gill-breathers;
3. *Apoda*, Limbless Batrachians or Cœcilians.

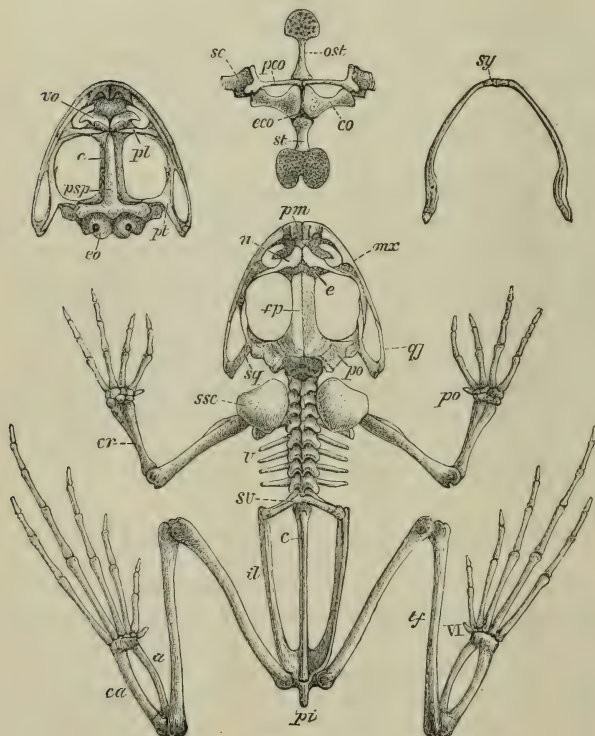
## Order I. ECAUDATA, OR TAILESS BATRACHIANS.

This order, which comprises about 1100 species, includes Batrachians destitute of a tail, with shortened body and four limbs, of which the hinder pair is longest and adapted for leaping.

Their skeleton shows many peculiarities. The following account refers to the Frog:—The skull is large and flattened, with enormous orbits; the vertebral column shortened, with constantly eight præ-sacral and one sacral vertebra, and a coccygeal style formed by the co-ossification of at least two caudal vertebræ. the following is an enumeration of the principal bones of the skull:—On the upper surface two large bones, the *fronto-parietals* (fig. 23, *fp*), formed by the fusion of the frontals and parietals, leaving uncovered anteriorly a portion of the *ethmoid* (*e*); a pair of *nasals* (*n*); the *prootic* (*po*) on each side between the fronto-

parietals and the *squamosal* (*sq*); the latter is a mallet-shaped bone, the basal extremity of which is in contact with a small bone, the *quadrato-jugal* (*qj*), which represents the quadrate and jugal

Fig. 23.

Skeleton of *Rana esculenta*.

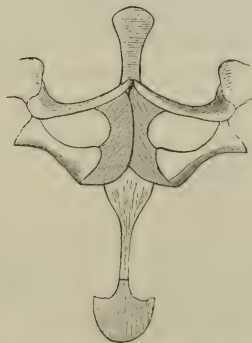
of higher Vertebrates; there are then two *premaxillæ* (*pm*) and two *maxillæ* (*mx*), bearing, in certain species, closely-set, small, acute teeth. On the lower surface we distinguish the *vomers* (*vo*), each of which bears sometimes a group of teeth, the *palatines* (*pl*), horizontal, rod-shaped bones, the *ethmoid* (*e*), a large T-shaped

*parasphenoid* (*psp*), and the *pterygoids* (*pt*). On the back of the skull are the *exoccipitals* (*eo*), with a condyle on either side of the *foramen magnum* for articulation with the first vertebra; there is no basioccipital. The toothless lower jaw is composed of several bones, as in the Reptiles, to which may be added on each side a peculiar *symphyseal* (*sy*).

The number of *præsacral vertebrae* (*v*) is normally eight; the ninth, or *sacral* (*sv*), gives attachment to the *pelvis*. The vertebrae possess strong transverse processes but no ribs, and, save in the first and last two, the centra are procœlous or concavo-convex. The *coccyx* or *urostyle* (*c*) is a long styliform bone, usually articulating with the sacral vertebra by a double concavity receiving the double condyles of the latter.

The pectoral arch (fig. 23) is composed of a pair of *precoracoids* (*pco*) and a pair of *coracoids* (*co*) nearly parallel, and firmly connected in the median line by a narrow cartilage, the *epicoracoid* (*eco*); this structure of the pectoral arch is termed the "Firmisternal," to distinguish it from the "Arciferous" type as seen in many families—for instance the Toads, in which the coracoid and

Fig. 24.



Sternal apparatus of *Leptodactylus pentadactylus*.

precoracoid on the one side are connected by an arched epicoracoid cartilage overlapping that of the other side (fig. 24). In front is the *omosternum* (*ost*), composed of a cartilaginous disk and a bony

style; posteriorly the *sternum* (*st*), similarly formed. Above the *scapula* (*sc*), on the dorsal side, is the *suprascapula* (*ssc*), partly cartilaginous. The fore limbs present this peculiarity, that the *ulna* and *radius* (*cr*) coalesce into a single bone; the functional digits number four, but there is a rudimentary thumb (*po*). The pelvic arch also differs much from that of higher Vertebrates; the *ilia* (*il*) are elongated bones set parallel to the vertebral column, and joining posteriorly the *pubis* and *ischium* (*pi*), which are united into a single small discoid bone. The acetabulum, or socket for the reception of the head of the femur, is far removed from the sacrum. In the hind limb also the *tibia* and *fibula* (*tf*) are united into a single bone, and the two proximal elements of the tarsus (*a*, *astragalus*; *ca*, *calcaneum*) are so elongated and strong as to resemble the real tibia and fibula of other animals—the Newts, for instance. The toes are also much elongated, and number five, with an additional ossicle (VI) on the inner side, which is regarded as a rudimentary sixth toe (*præhallux*).

The Tailless Batrachians are distributed over the whole surface of the globe except the Arctic Regions, and are most abundant in the tropical and subtropical zones. They are divided into two suborders and fifteen families as follows:—

Suborder PHANEROGLOSSA, furnished with a tongue, and with the internal ear-openings separated.

Series A. *Firmisternia* \*.

Families:—1. *Ranidæ*. 2. *Dendrobatidæ*. 3. *Engystomatidæ*. 4. *Dyscophidæ*. 5. *Ceratobatrachidæ*.

Series B. *Arcifera* \*.

Families:—6. *Cystignathidæ*. 7. *Dendrophryniscidæ*. 8. *Bufo-  
nidæ*. 9. *Hylidæ*. 10. *Pelobatidæ*. 11. *Discoglossidæ*. 12. *Am-  
phignathodontidæ*. 13. *Hemiphractidæ*.

Suborder II. AGLOSSA, without tongue, and with a single internal ear-opening.

Families:—14. *Dactylethridæ*. 15. *Pipidæ*.

\* For the meaning of this term see p. 35.



The *Ranidæ*, or true Frogs, have teeth in the upper jaw ; the transverse processes of the sacral vertebra are not distinctly dilated. Two species occur in this country : the common Frog (*Rana tem-*

Fig. 25.

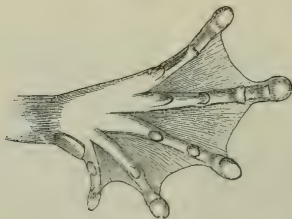


*Rana temporaria* (Common Brown Frog).

*poraria*) is indigenous ; the second species, the Edible Frog of the Continent (*R. esculenta*), has probably been introduced, and has thoroughly established itself in some parts of Norfolk. The Bull-Frogs, so called from their bellowing powerful voice, are *R. catesbiana* of North America, and *R. tigrina*, the largest Frog of India ; *R. adspersa*, also one of the largest species, is found in various parts of tropical Africa, and remarkable for its toad-like appearance. The largest known Frog is *Rana guppyi*, from the Solomon Islands, the body of which measures nearly a foot. This family also contains arboreal types, of which *Rhacophorus maximus*, from the Himalayas and the hills of Assam, is a representative. In this genus the webs between the fingers and toes are much developed and very broad, so that some naturalists have represented this structure to be of service to the frog in taking flying leaps

(the Flying Frog of Wallace). What is certain is that the disk-like dilatations of the tips of the fingers act as adhesive organs (fig. 26), by means of which the animal attaches itself to vertical or smooth surfaces, as may be observed in the common Tree-Frog from the continent, which is frequently kept in captivity in this country.

Fig. 26.



Foot of *Hylambates palmatus*.

The *Dendrobatidæ* are small Tree-Frogs, closely allied to the preceding family, but destitute of teeth, in which respect they resemble the Toads. The savage tribes of some parts of South America extract a deadly poison for their arrows from *Dendrobates tinctorius*, of which a specimen is exhibited, and from other allied species.

The *Cystignathidæ* represent the *Ranidæ* in tropical America and Australia. They differ from the true Frogs in the structure of the sternal apparatus, which, as in Toads, belongs to the "Arciferous" type. Several of the genera lack altogether a web between the toes (*Leptodactylus*), whereas others (e. g. *Pseudis*) have the toes extensively webbed. *Pseudis* was believed by the earliest observers who studied the fauna of the Guianas to reverse the course of the ordinary metamorphosis and to change into a fish. This fable originated in the enormous size of the tadpole, which frequently far exceeds that of the perfect animal. Several of these larvæ are exhibited. The *Ceratophrys*, or Horned Frogs, also belong to this family.

The *Buфонidæ*, or true Toads, have no teeth, and the transverse processes of the sacral vertebra are more or less strongly dilated or hatchet-shaped. Two species, *Bufo vulgaris* (the Common Toad) and *Bufo calamita* (the Natterjack), represent this group in the

Fig. 27.

*Ceratophrys cornuta* (Horned Frog).

British Isles. The largest species is the Agua Toad (*Bufo marinus*) of South America, which attains to a length of 8 inches, the limbs not included, and which possesses enormous parotoid glands.

The *Hylidæ*, or true Tree-Frogs, resemble very closely the arboreal *Ranidæ* as regards form and habits; but the structure of their skeleton proves their affinity to the Toads, from which they are distinguished by the presence of teeth in the upper jaw. The large Tree-Frog exhibited, *Hyla dolichopsis*, from New Guinea, and the common European species, *Hyla arborea*, are examples. Closely allied to *Hyla* is *Nototrema* (fig. 28), a marsupial Frog provided with a dorsal pouch, into which the ova are introduced (probably by the male) immediately after they are laid, and preserved from injury until hatched. The commonest species, *N. marsupiatum*, is a native of the Andes of Ecuador. The species of *Phyllomedusa*, or "quadrumanous" Frogs, are still more strongly adapted to arboreal life, the first digit of both hands and feet being opposable to the others, like the thumb of the hand. Several species are known from tropical America.

Fig. 28.

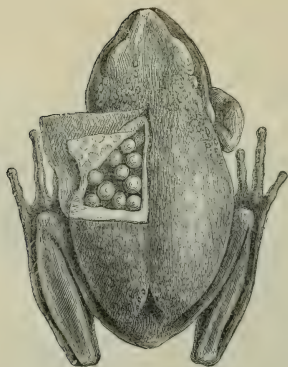
*Nototrema marsupiatum*, from Ecuador.

Fig. 29.

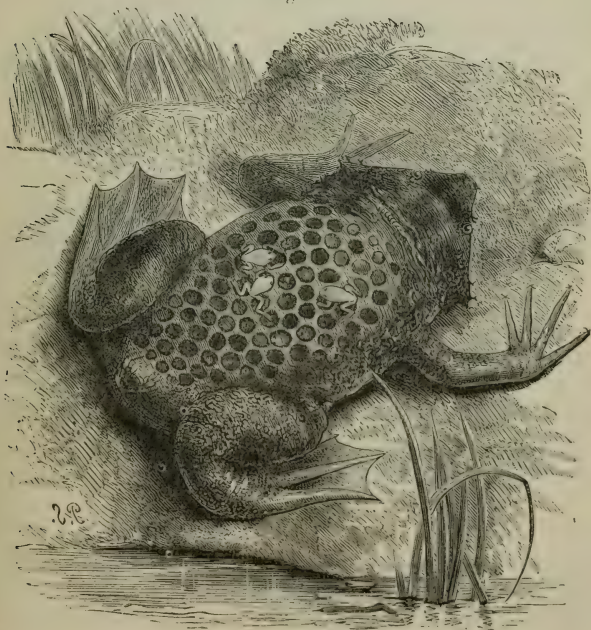
*Xenopus laevis*, from Tropical Africa.



The *Discoglossidæ* differ from all the preceding families in possessing short ossified rudimentary ribs, and the vertebræ, instead of being procœlous, are opisthocœlous, two characters in which they approach the Newts. They are represented by but few species; among them the Yellow- and Fire-bellied Toads (*Bombinator pachypus* and *B. igneus*), so abundant in many parts of Germany, and the curious "Midwife Toad" (*Alytes obstetricans*), an inhabitant of Western Europe: the latter owes its name to the assistance rendered by the male to his mate during the deposition of the ova; he twists the strings of ova round his legs and carries them until they reach maturity.

The *Amphignathodontidæ* and *Hemiphractidæ*, as well as the *Ceratobatrachidæ* of the series *Firmisternia*, are remarkable for possessing teeth in the lower as well as in the upper jaw.

Fig. 30.



*Pipa americana* (Surinam Toad).

The *Dactylethridæ* (*Xenopus*, fig. 29) of tropical Africa and the *Pipidæ* of South America are small groups which form the suborder of tongueless Frogs—the former being chiefly distinguished by the presence of teeth in the upper jaw, whereas the latter are toothless. The Surinam Toad (*Pipa americana*, fig. 30) is well known for its curious mode of reproduction, the eggs being placed by the male in cells on the back of the female, where they remain until the completion of the metamorphosis.

## Order II. CAUDATA, or TAILED BATRACHIANS.

Elongate, lizard- or eel-like in form, with two, or, exceptionally, one pair of limbs and with a tail. Short ribs are constantly present, and the vertebral centra are biconcave or opisthocœlous. Over 100 species are known, from Europe, Temperate Asia, North Africa, and North and Central America, but they are entirely absent in the Southern Hemisphere. They are arranged in four families:—

1. *Salamandridæ*. 2. *Amphiumidæ*. 3. *Proteidæ*. 4. *Sirenidæ*.

Fig. 31.



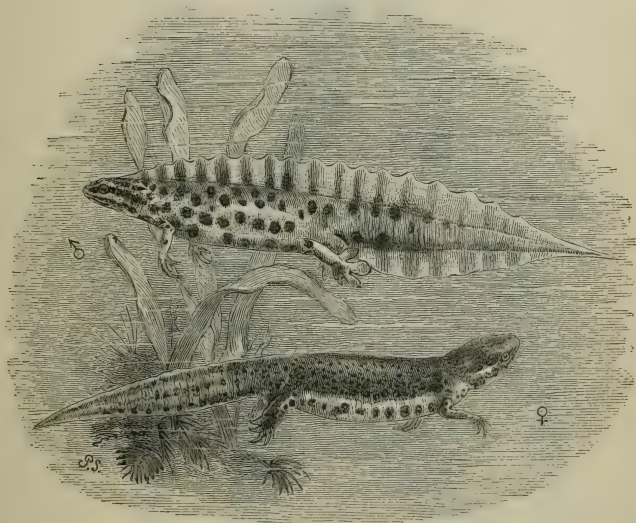
*Amblystoma tigrinum* (Axolotl of Mexico).

The *Salamandridæ*, or Newts and Salamanders, lose their gills before they reach the adult state. However, there are instances occurring in various genera, of which the Axolotl (fig. 31) is the



best known, of specimens retaining the gills throughout life whereas other individuals of the same species undergo the regular metamorphosis. The yellow-and-black-spotted Land-Salamander (*Salamandra maculosa*) is very common over nearly the whole of Europe and in North Africa. Three species of Newts (*Molge*) are found in Great Britain, viz. the large Crested Newt (*M. cristata*), the Common Smooth Newt (*M. vulgaris*, fig. 32), and the Palmated Newt

Fig. 32.



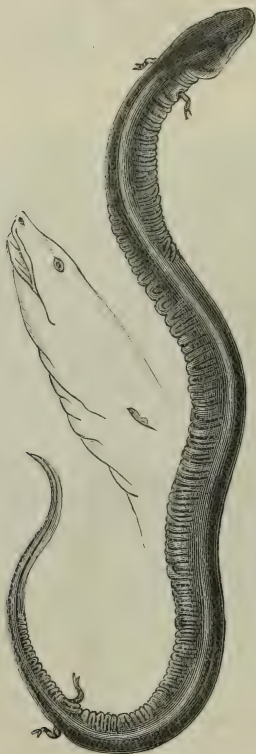
*Molge vulgaris* (Common Smooth Newt), male and female.

(*M. palmata*). These species live in the water in spring and during part of the summer, whilst they are engaged in depositing their eggs, at intervals coming to the surface for the purpose of respiration. The remainder of the year they pass on land.

The *Amphiumidæ* are exclusively aquatic, although they lose the gills during metamorphosis. They are easily distinguished from the *Salamandridæ* by the absence of eyelids. The species of *Amphiuma* (fig. 33) are eel-like creatures, with very small limbs, from North

America. The Gigantic Salamander (*Megalobatrachus maximus*), from Japan and China, belongs to this family; it is the largest living Batrachian, attaining a length of four feet, and the living

Fig. 33.



*Amphiuma means*, from North America.

representative of the fossil Salamander of Eningen, the remains of which were originally regarded as those of man (*Homo diluvii testis*).

The *Proteidæ* and *Sirenidæ* are permanent gill-breathers, and

distinguished from the preceding families by the absence of maxillary bones. *Proteus anguinus* (fig. 34) inhabits the subterranean waters of the caves of Carniola, and in consequence of its long sojourn in absolute darkness its eyes have become rudimentary and are concealed in the skin, which is devoid of pigment.

Fig. 34.



Fig. 35.

Fig. 34. *Proteus anguinus*, from the caves of Carniola.Fig. 35. *Siren lacertina*, from North America.

*Siren* (*S. lacertina*, fig. 35), a native of North America, possesses only one pair of limbs, viz. the anterior.

## Order III. APODA, OR LIMBLESS BATRACHIANS.

Fig. 36.

*Urotyphlus africanus.*

These are worm-like burrowing creatures, destitute of limbs, without or with only a rudimentary tail, frequently with small scales imbedded in the skin; the vertebræ are biconcave. About 35 species are known, belonging to one family, *Cæciliidæ*, which is found in tropical Africa, the East Indies, and tropical America. A specimen of *Siphonops annulatus*, the commonest species in South America, and a skeleton of *Ichthyophis glutinosus*, from the East Indies, are exhibited. The species figured (fig. 36) inhabits West Africa. Very little is known of their habits; the majority seem to live buried in mud or very soft moist soil, some in water. The ova are of large size and few in number. Some species are ovoviviparous. *Ichthyophis* deposits its eggs, shortly after impregnation, in a hole in damp earth. These eggs form a small mass, which the mother protects by coiling herself round it.

In the embryo large external gills are developed within the egg; and the larva is provided with an opening, or spiraculum, on each side of the neck.

# THE FISH GALLERY.

---

VISITORS who desire to inspect the exhibited series of Fishes have to pass from the Bird-Gallery on the ground-floor by the first corridor on the right-hand side into a large side Gallery, as shown on the plan accompanying this Guide. The contents are chiefly stuffed specimens\* and skeletons; the former arranged in a continuous series in the Wall-cases numbered 1-44, the latter in Table-cases marked A-G. Large objects are exhibited in special cases, or placed on stands on the floor of the Gallery, or suspended on the walls or from the ceiling.

## GENERAL NOTES.

The class of Fishes, of which now some 13,000 species are known, exhibits a much greater amount of variation of external form, and of diversity of their principal internal organs, than any of the higher Vertebrates. But as all, without exception, live in the water throughout life, they possess common distinctive characters in those systems of their organization which are in direct relation to their aquatic mode of life, viz. in the organs of respiration and locomotion.

Fishes, therefore, may be described as vertebrate animals living in water, and breathing the air dissolved in the water by means of gills or branchiæ; whose heart consists of two chambers only, viz. a single ventricle and single atrium; whose limbs, if present, are modified into fins, supplemented by unpaired, median fins; and whose skin is either naked or covered with scales or osseous scutes or bucklers. With few exceptions, Fishes are oviparous.

\* The collection of Fishes preserved in spirit is placed with other similar preparations in a separate locality, such specimens being preserved to meet the requirements of the scientific student, and generally unsuitable for exhibition.

The earliest fossil remains referred to this class are found in the Lower Silurian, in the form of small horny bodies which have been regarded as teeth of Cyclostomes or Lampreys. But the first undeniable evidence of a Fish, probably a Plagiostome, occurs in the Upper Silurian; from the Devonian to the Cretaceous, Ganoids were extremely abundant and exhibited an endless variety of forms, many of which recall, with regard to external appearance, the Teleosteans of the present time; from the former formation started also Chondropterygians and other Palæichthyes; in the Tertiary Epoch the Teleosteans almost entirely replaced the Ganoids, and have continued to be the predominant type of Fishes down to our times.

Fishes are distributed over all the waters of the globe, and may, on the whole, be divided into *Freshwater* and *Marine* forms. However, a sharp line cannot be drawn between these two kinds of Fishes, for there are not only species which can gradually accommodate themselves to a sojourn in either salt or fresh water, but there are also such as seem to be quite indifferent to a rapid change from one to the other, as, for instance, Sticklebacks and some species of *Clupea*, or Herrings. Further, Fishes belonging to freshwater genera descend rivers and sojourn in the sea for a more or less limited period; whilst others annually or periodically ascend rivers for the purpose of spawning—for instance, the Salmon and many Sturgeons. Marine Fishes fall, with regard to their life and distribution, into three divisions:—1. *Shore Fishes*, that is, Fishes which inhabit chiefly parts of the sea in the immediate neighbourhood of land or banks; 2. *Pelagic Fishes*, which inhabit the surface and uppermost strata of the open ocean, and approach the shores only accidentally or occasionally (in search of prey), or periodically (for the purpose of spawning); 3. *Deep-sea Fishes*, which inhabit such depths of the ocean as to be but little or not at all influenced by light or the surface temperature, and which, by their organization, are prevented from reaching the surface stratum in a healthy condition. But it must not be imagined that these three divisions are more sharply defined than Freshwater and Marine Fishes, and, like these latter, they gradually pass into each other.

A number of *Skeletons* are exhibited in separate cases and table-



Fig. 37.



### Skeleton of Perch.

cases. An idea of the principal features of the bony framework of a typical Fish may be given in the two accompanying engravings—of the skeleton of the Perch (fig. 37), as illustrative of the Teleostean type, and of a Chondropterygian (fig. 42, p. 55), *Carcharodon rondeletii*.

Like that of the higher Vertebrates, the skeleton of a Fish consists of the *Skull* (from which a branchial apparatus is suspended), the *Vertebral column*, composed of vertebræ to which ribs are attached, the *Scapular arch*, giving attachment to the fore limbs (pectoral fins), and the *Pelvic arch*, giving attachment to the hind limbs (ventral fins). Besides these parts, the typical Fish possesses a series of dermal bones, spines, or rays, forming the vertical fins, viz. dorsal, anal, and caudal.

Looking at the Perch's skull from the side (fig. 37), we distinguish:—The *præmaxillary* (17), armed with teeth, and, parallel to it, the toothless *maxillary* (18). The *mandible* (34), the right and left rami of which are united by a ligament in front; each ramus is formed of three pieces, viz. the *articulary* (36), *angular* (35), and *dentary* (34) bones, the latter armed with teeth. An infra-orbital ring of bones (19), of which the anterior is the largest and named *præorbital*. Four large bones, constituting the gill-cover, and distinguished as *præoperculum* (30), *operculum* (28), *suboperculum* (32), and *interoperculum* (33).

The chain of flat bones which, after the removal of the temporal muscles, appear arranged within the inner concavity of the preoperculum, are comprised with the latter under the common name of *mandibulary suspensorium*. They are:—The *epitympanic* (23), the *mesotympanic* (31), the *pretympanic* (27), and the *hypotympanic* or *quadrate* (26), which has a condyle for the mandibulary joint.

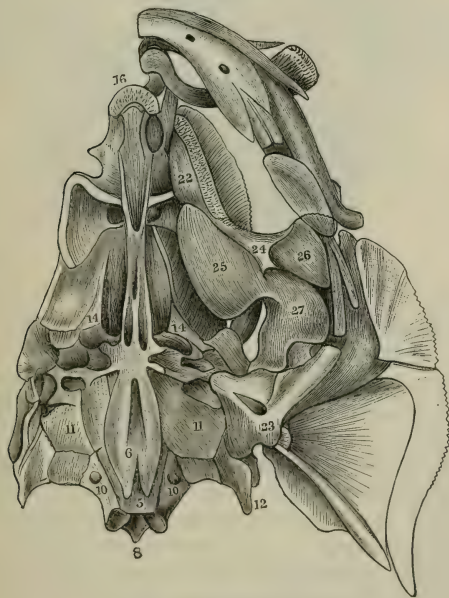
The palatine arch connects the suspensorium with the anterior extremity of the skull and is formed by three bones—the *entopterygoid* (fig. 38, 25), the *pterygoid* (24), and the *palatine* (22); the latter is toothed.

In the occipital region (fig. 38) we have the *basioccipital* (5), readily recognized by the conical excavation corresponding and similar to that of the atlas, with which it is articulated through the intervention of a capsule filled with a gelatinous substance (the

remains of the notochord) ; on each side, the *exoccipital* (10) ; and the *supraoccipital* above (8), which is raised into a crest. The formation of the posterior part of the skull is completed by the *mastoids* (12) and *parietals* (7).

On the lower surface of the skull (fig. 38) are seen the *basi-*

Fig. 38.



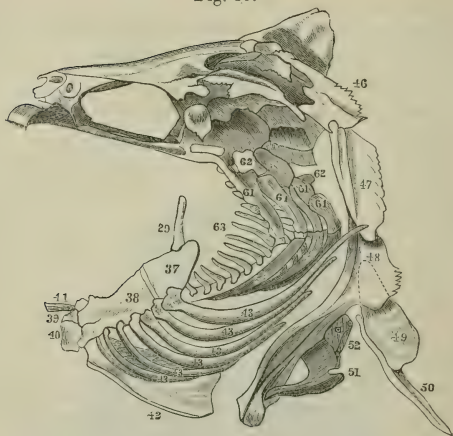
Lower view of skull of Perch.

*sphenoid* (6), the *vomer* (16), which, like the palatines, is beset with teeth, the *alisphenoids* (11), and *orbitosphenoids* (14).

In addition to these bones we have to notice those of the upper surface of the skull (fig. 37), viz. the *frontals* (1), the *præfrontals* (2), the *postfrontals* (4), and the *turbinals* (20), all paired bones.

Attached to the skull are the hyo-branchial apparatus and the scapular arch (figs. 39, 40).

Fig. 39.

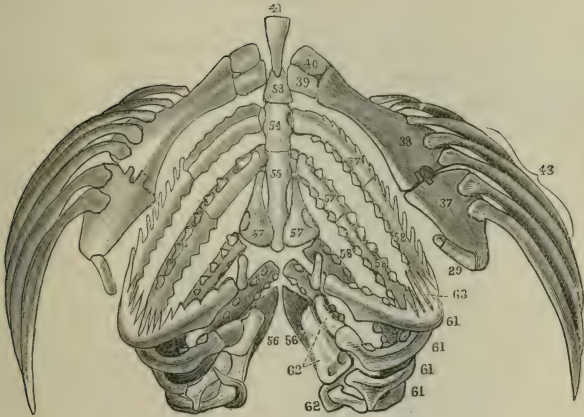


Hyoid and scapular arches of Perch.

The *hyoid* arch is suspended on each side by a slender styloform bone, the *stylohyal* (29), from the hyomandibulars; it consists of three segments—the *epihyal* (37), *ceratohyal* (38), and *basihyal* (39, 40), the latter formed by two juxtaposed pieces. A median ossicle, extending forwards into the substance of the tongue, is called *glossohyal* or *os linguale* (41). And below the junction of the two hyoid branches there is a vertical single bone (42), expanded along its lower edge, which, connected by ligament with the anterior extremity of the humeral arch, forms the *isthmus* separating the gill-openings. This bone is called the *urohyal*. Articulated or attached by ligaments to the epihyals and ceratohyal are a number of sword-shaped bones or rays (43), the *branchiostegals*, between which the branchiostegal membrane is extended.

The *branchial arches* (fig. 40) are enclosed within the hyoid arch, with which they are closely connected at the base. They are five in number, of which four bear gills, whilst the fifth (56) remains dwarfed, is beset with teeth, and called the *lower pharyngeal* bone. The arches adhere by their lower extremities to a chain of ossicles (53, 54, 55), *basibranchials*. Each of the first three branchial arches consists of four pieces. The lowest is the

Fig. 40.



Hyoid and branchial arches of Perch.

*hypobranchial* (57), the next much larger one the *ceratobranchial* (58), and above this, a slender and a short irregularly-shaped *epibranchial* (61). In the fourth arch the hypobranchial is absent. The uppermost of these segments (62), especially of the fourth arch, are dilated and more or less confluent; they are beset with fine teeth, and generally distinguished as the *upper pharyngeal bones*. Only the ceratobranchial is represented in the fifth arch or lower pharyngeal. On their outer convex side the branchial segments are grooved for the reception of large blood-vessels and nerves; on the inner side they support horny processes (63), called the *gill-rakers*, which do not form part of the skeleton.

The *scapular* or *humeral arch* (fig. 39) is suspended from the skull by the *suprascapula* (46); then follows the *scapula* (47), and the arch is completed below by the union of the *coracoid* (48) with its fellow. Two flat bones (51, 52) attached to the coracoid may be regarded as *radius* and *ulna*; and two series of small bones (53) between the forearm and the fin (54) as *carpals* and *metacarpals*. A two-jointed appendage, the *epicoracoid* (49, 50), is attached to the clavicle.

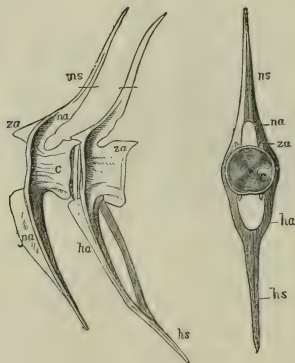
The *pelvic arch* (fig. 37) is reduced to a pair of flat bones, called *pubic bones* (80), to which the ventral fins (81) are articulated.



The series of bones constituting the axis of the body, and destined to protect the spinal cord and some large longitudinal blood-vessels, is called the *vertebral* or *spinal column*; the single bones are the *vertebræ*.

The *vertebra* consists of a body or *centrum* (fig. 41, *c*), with a concave anterior and posterior surface, and of several *processes* or

Fig. 41.



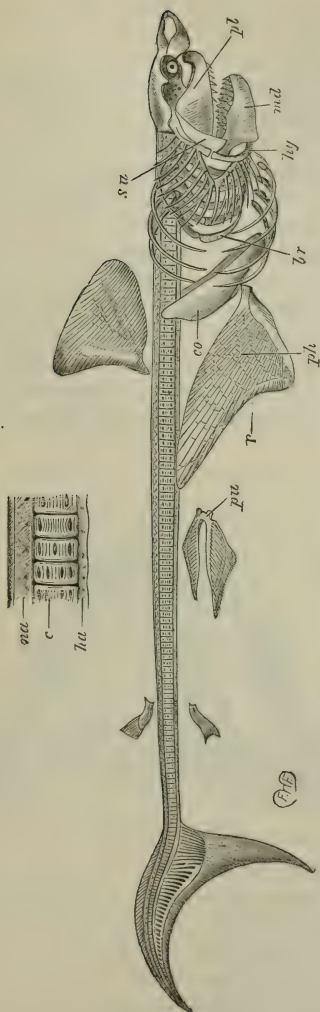
Vertebra of Fish.

*apophyses*, as:—1. Two *neurapophyses* (*na*) which, on the dorsal side, rising upwards, form the *neural arch* over the canal, in which the spinal cord is lodged. 2. Two *parapophyses* (*pa*), projecting from the lower part of the sides of the body, or two *hæmapophyses* (*ha*), which coalesce to form on the ventral side the hæmal canal for a large trunk of the vascular system. 3. A *neural spine* (*ns*), which crowns the neurapophyses. 4. A *hæmal spine* (*hs*), having the same relation to the hæmapophyses. 5. Two *pleurapophyses* or floating *ribs*, suspended from the parapophyses. 6. Oblique articular processes, *zygapophyses* (*za*), developed from the base of each neurapophysis.

The *vertebræ* are divided into *abdominal* and *caudal*, the latter distinguished by the coalescence of the parapophyses into a complete hæmal ring; the suspension of the anal fins forms the boundary between the two divisions (fig. 37). The abdominal *vertebræ*,



Fig. 42.

Skeleton of *Carcharodon rondeletii*.

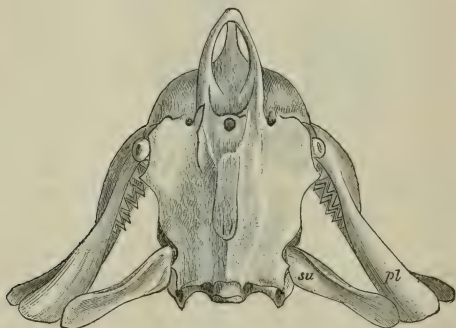
(F. 16)

with the exception of the first (atlas) and last, are provided with ribs, many of which are bifid (72). A series of flat spines (73), called *interneurals*, to which the spines and rays of the dorsal fins (*d*) are articulated, are supported by the neural spines. A similar system of bones, the *interhæmals* (79), afford the base for the articulation of the rays of the anal fin (*a*). The last and smallest caudal vertebra articulates with the *hypural* (70), a fan-like bone, which, together with the dilated hindermost neural and hæmal elements, supports the caudal rays (*c*).

As an example of the Chondropterygian type, a figure of the skeleton of *Carcharodon rondeletii*, which is exhibited in the Entrance Hall, is given here (fig. 42, p. 55).

The substance of the skull is cartilage. The articulation with the vertebral column is effected by a pair of lateral condyles, and a central conical excavation corresponds to that of the centrum of the first vertebra. The cranium itself is an undivided

Fig. 43.

Skull of *Carcharodon*.

cartilage, with three rod-like plates forming the base of the projecting conical snout. As separate cartilages there are appended to the skull a suspensorium (*su*), a palatine (*pl*), mandible (*md*), hyoid (*hy*), and rudimentary maxillary elements. The suspensorium is movably attached to the side of the skull. What is generally called the upper jaw of a Shark is not the maxillary, but the palatine. It consists of two simple lateral halves, each of

which articulates with the corresponding half of the lower jaw. Both upper and lower jaws are armed with teeth.

The hyoid consists of a pair of long and strong lateral pieces and a single mesial piece. From the former cartilaginous filaments (representing branchiostegals) pass directly outwards. Branchial arches (*br*), similar to the hyoid, succeed it; and are suspended from the side of the foremost part of the spinal column, and, like the hyoid, bear a number of cartilaginous filaments.

The vertebral column is composed of a series of centra (*c*), conically excavated in front and behind, with a central canal through which the notochord is continued, and with neural (*na*) and hæmal (*ha*) apophyses. The caudal extremity of the vertebral column shows a heterocercal condition, *i.e.* its axis is turned upwards and the hæmapophyses are much more developed than the neurapophyses. The vertical fins are supported by interneural and interhæmal cartilages, to which the fin-rays are attached without articulation.

The scapular arch is formed by a single coracoid cartilage (*co*) bent from the dorsal region downwards and forwards, not suspended from the skull as in the majority of Teleosteans. Behind, at the point of its greatest curvature, three carpal cartilages are joined to the coracoid, which are distinguished as *propterygium*, *mesopterygium*, and *metapterygium*, the former occupying the front, the latter the hind margin of the fin. Several transverse series of styliform cartilages (*ph*) follow; they represent the phalanges, to which the horny filaments (*r*), which are imbedded in the skin of the fin, are attached.

The pubic is represented by a single median transverse cartilage (*pu*), with which a tarsal cartilage articulates. The latter supports the phalanges and fin-rays. To the end of this cartilage is also attached, in the male, a peculiar accessory generative organ or clasper.

The Class of Fishes is divided into 3 Subclasses and 9 Orders:—

Subclass I. TELEOSTEI. Heart with a non-contractile bulbus arteriosus; intestine without spiral valve; optic nerves decussating. Skeleton ossified, with completely separated vertebrae.

Orders:—1. *Acanthopterygii*. 2. *Acanthopterygii Pharyngo-*

*gnathi.* 3. *Anacanthini.* 4. *Physostomi.* 5. *Lophobranchii.*  
6. *Plectognathi.*

Subclass II. PALÆICHTHYES. Heart with a contractile conus arteriosus; intestine with a spiral valve; optic nerves non-decussating or only partially decussating.

Orders :—7. *Ganoidei.* 8. *Chondropterygii.*

Subclass III. CYCLOSTOMATA. Heart without bulbus arteriosus; intestine simple. Skeleton cartilaginous or notochordal. One nasal aperture only. No jaws; mouth surrounded by a circular lip.

Order :—9. The Lampreys.

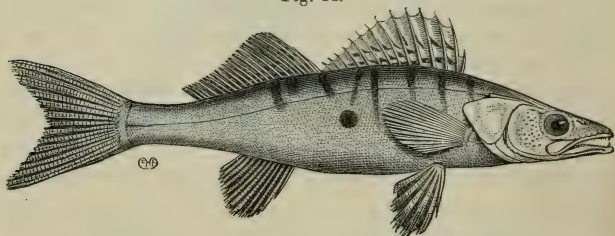
In many works on Fishes a fourth Subclass, *Leptocardii*, is admitted; it comprises the Lancelet (*Branchiostoma*) only, which, however, differs so much not only from the Class of Fishes, but from the general Vertebrate type, that in a strictly systematic account it should be referred to a distinct class.

## TELEOSTEI.

Order I. ACANTHOPTERYGII, OR SPINY-RAYED FISHES.

Acanthopterygians are bony fishes in which part of the dorsal, anal, and ventral fins are non-articulated, more or less pungent

Fig. 44.



The Pike-Perch (*Lucioperca sandra*): a Spiny-rayed Fish.

spines; the lower pharyngeal bones are generally separated; the air-bladder, if present, is without pneumatic duct in the adult. This Order, the most numerous in species, is divided into a great

number of Families, many of which can be alluded to here by name only :—

1. *Percidæ* (Perches). 2. *Berycidæ*. 3. *Aphredoderidæ*. 4. *Mullidæ* (Red Mulletts). 5. *Sparidæ* (Sea-Breams). 6. *Squamipinnes* (Coral-fishes). 7. *Cirrhitidæ*. 8. *Scorpænidæ*. 9. *Cottidæ* (Bullheads, Gurnards). 10. *Trachinidæ* (Weevers). 11. *Sciænidæ* (Meagres). 12. *Polynemidæ*. 13. *Sphyrænidæ* (Barraendas). 14. *Trichiuridæ* (Hair-tails). 15. *Scombridæ* (Mackerel). 16. *Carangidæ* (Horse-Mackerels). 17. *Xiphiidæ* (Sword-fishes). 18. *Gobiidæ* (Gobies). 19. *Discoboli* (Lumpsuckers). 20. *Oxudercidæ*. 21. *Batrachidæ*. 22. *Pediculati* (Frog-fishes). 23. *Blenniidæ* (Blennies). 24. *Acanthoclinidæ*. 25. *Comphoridæ*. 26. *Trachypteridæ* (Ribbon-fishes). 27. *Lophotidæ*. 28. *Teuthididæ*. 29. *Acronuridæ* (Surgeons). 30. *Hoplognathidæ*. 31. *Malacanthidæ*. 32. *Nandidæ*. 33. *Polycentridæ*. 34. *Labyrinthici*. 35. *Luciocephalidæ*. 36. *Atherinidæ* (Atherines). 37. *Mugilidæ* (Grey Mulletts). 38. *Ophiocephalidæ*. 39. *Trichonotidæ*. 40. *Cepolidæ* (Band-fishes). 41. *Gobiesocidæ*. 42. *Psychrolutidæ*. 43. *Centriscidæ*. 44. *Gastrosteidæ* (Sticklebacks). 45. *Fistulariidæ* (Flute-mouths). 46. *Mastacembelidæ*.

The Acanthopterygians occupy Wall-cases 1 to 14, and skeletons are exhibited in Table-cases 1 and 2.

The *Percidæ*, or Perch-family (Cases 1–5), constitute a large family of which the common Freshwater Perch (*Perca fluviatilis*) is the best-known example. This fish is generally distributed over Europe and Northern Asia, and equally common in North America. The Bass (*Labrax*) are common on the coasts of Europe and in the fresh waters of North America (*L. lineatus*, *L. rufus*, &c.); the best-known European species (*L. lupus*) is an inhabitant of the sea, entering brackish but never fresh water. [Cases 1–5.]

The Pike-Perches (*Lucioperca*) are inhabitants of lakes and rivers of Europe, temperate Asia, and North America; the European species (*L. sandra*) is one of the most esteemed freshwater fishes, and attains to a length of 3 or 4 feet and to a weight of from 25 to 30 lb. The Black Bass of North America (*Huro nigricans*) is an esteemed food-fish, the introduction of which into Germany is an accomplished fact. The Sea-Perches proper (*Ser-*

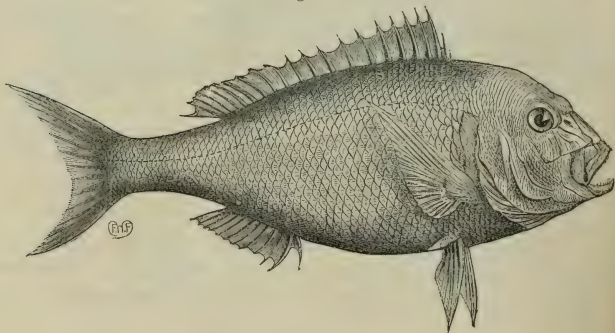


*ranus* and *Epinephelus*) are found on the shores of all temperate and tropical seas, and extremely numerous in species. Some (*Epinephelus lanceolatus* and others) attain to a size of over 7 feet, and become then dangerous to man. Several fine specimens of these gigantic Sea-Perches are exhibited in separate cases opposite the wall-cases.

The *Mullidæ*, or Red Mulletts (Case 5), are characterized by the rather low and slightly compressed body, covered with large thin scales; two long erectile barbels are suspended from the hyoid, and can be laid backwards in the hollow at the lower side of the head; the mouth is rather short, and the teeth are very feeble; two short dorsal fins remote from each other, the first with feeble spines. They are marine fishes, celebrated for the delicacy of their flesh. The European Mullet (*Mullus barbatus*) was prized by the ancient Romans above any other fish.

The *Sparidæ*, or Sea-Breams (Cases 5, 6), are recognized chiefly by their dentition, which consists of either cutting-teeth in front of the jaws or molar teeth on the sides. By the latter they are enabled to crush and feed on hard-shelled crustaceans or mollusks. The Gilt-head (*Chrysophrys aurata*) is common in the Mediterranean, but occasionally found on the south coast of England. Other British species belong to the genera *Pagellus* (*P. erythrinus*, *P. centrodontus*, the common Sea-Bream or Chad) and *Cantharus* (*C. lineatus*). One of the largest species is the "Sheep's-head" (*Sargus ovis*), from the coast of the United States, which attains to a weight of 15 lb., and

Fig. 45.



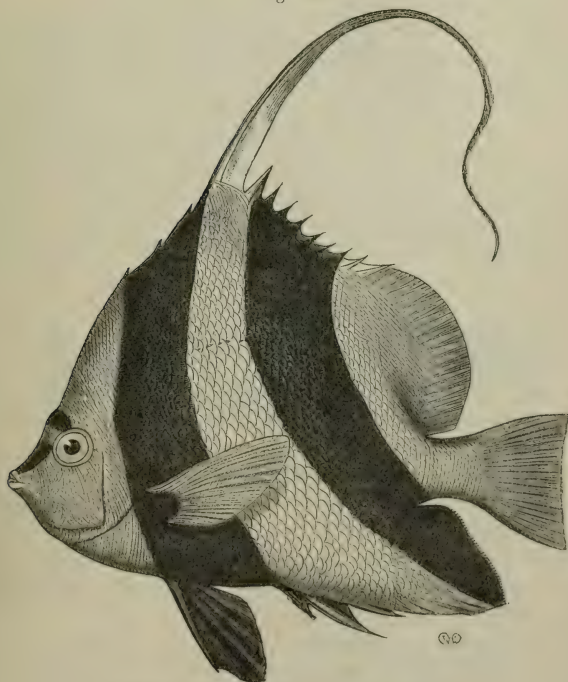
The Snapper (*Pagrus unicolor*).



is highly esteemed on account of the excellency of its flesh. The "Snapper" (*Pagrus unicolor*) is one of the best-known sea-fishes of Southern Australia and New Zealand; it attains to a length of more than 3 feet and to a weight exceeding 20 lb.

The *Squamipinnes*, or Coral-fishes (Case 7), are inhabitants of the tropical seas, and abound chiefly in the neighbourhood of coral-reefs. They attain only small dimensions, and comparatively few are used as food. They are carnivorous, feeding on small invertebrates. The typical forms of this family are readily recognized by the short and deep form of their body, and by having the soft, and frequently also the spinous, part of their [Case 7.]

Fig. 46.



*Heniochus macrolepidotus*. (Indian Ocean.)

dorsal and anal fins so thickly covered with scales that the boundary between fins and body is entirely obliterated. The beauty and singularity of distribution of the colours of some genera (*Chætodon*, *Heniochus*, *Holacanthus*) is scarcely surpassed in any other group of fishes. The genus *Chelmo* is remarkable in having the snout produced into a long tube, which probably enables the fish to draw from holes and crevices animals which otherwise could not be reached by it. A well-known species from the East Indies is *Toxotes jaculator*. It has received its name from its habit of throwing a drop of water at an insect which it perceives close to the surface in order to make it fall into it. The Malays keep it in a bowl in order to witness this singular habit, which it continues even in captivity.

[Case 7.] The *Scorpenidæ* (Case 7) are carnivorous marine fishes, many of which possess skinny appendages resembling the fronds of seaweeds, by which they either attract other fishes or by which they are enabled more effectually to hide themselves. The dentition is feeble, but some of the bones of the head are armed with spines. To this family belong the *Sebastes*, which approach the Sea-Perches in forms and habits; the *Scorpena*, the head of which is strongly armed with spines, and generally furnished with skinny tentacles. Allied to the preceding is *Pterois volitans*. The dorsal spines and pectoral rays of this fish are much prolonged, passing beyond the margin of the connecting membrane. It is one of the most singularly formed and most beautifully coloured fishes of the tropics, and was formerly believed to be able to fly like *Dactylopterus*. But the membrane connecting the pectoral rays is much too short and feeble to enable it to raise itself from the surface of the water. The species of the genus *Synanceia* are justly feared on account of the dangerous wounds which they can inflict with their poisonous dorsal spines. The terminal half of each spine is provided with a deep groove on each side, at the lower end of which lies a pear-shaped bag containing the milky poison. This sac is prolonged into a membranous duct, lying in the groove of the spine, and open at its point.

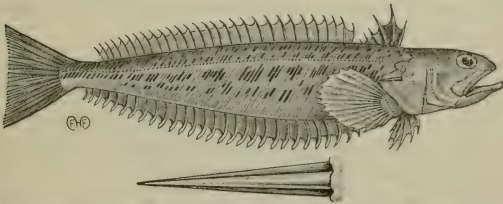
[Case 8.] The *Cottidæ*, or Gurnards (Case 8), are fishes of singular appearance, nearly all marine, bad swimmers, and generally living at the bottom near the coasts. Their body is oblong, subcylindrical,

their head thick. The dentition is feeble. Some bones of the head are armed, and a bony stay connects the preopercular spine with the infraorbital ring. The "Bull-heads," or "Millers'-thumbs" (*Cottus*), are small fishes from the shores and fresh waters of Northern Europe, Northern Asia, and North America. The common British Miller's-thumb (*C. gobio*) is exclusively confined to fresh waters; two marine species are common on our coasts (*C. scorpius* and *bubalis*), whilst a fourth (*C. liljeborgii*) inhabits deeper water on the North-British coasts. The Gurnards (*Trigla*), of which seven species occur on the British coast, are principally characterized by the free finger-like pectoral appendages which serve as organs of locomotion as well as of touch. The Flying-Gurnards (*Dactylopterus*), of which three species are known, are very abundant in the Mediterranean, the tropical Atlantic, and Indo-Pacific. They and the "Flying-Herrings" (*Exocoætus*) are the only fishes which are enabled by their long pectoral fins to take flying leaps out of the water, and deserve the name of "Flying-fishes"; when young their pectorals are much shorter, and consequently they are unable to raise themselves out of the water.

The *Trachinidæ* (Case 8) have the body elongate, naked, or covered with scales, and the spinous portion of the dorsal fin always much shorter than the soft. The Weevers (*Trachinus*) are

[Case 8.]

Fig. 47.

The Weever (*Trachinus draco*); with separate view of opercular spine.

common fishes on the European coasts, and but too well known to all fishermen. Wounds by their dorsal and opercular spines are much dreaded, being extremely painful, and sometimes causing violent local inflammation. In the absence of any special poison-organ, it is very probable that the mucous secretion in the vicinity of the spines has poisonous properties. The dorsal spines as well

as the opercular spine have a deep double groove in which the poisonous fluid is lodged, and through which it can be inoculated in the punctured wound.

The *Sciænidae* (Cases 8, 9) are chiefly coast-fishes of the tropical and subtropical Atlantic and Indian Oceans, frequently entering the mouths of large rivers. Some of the larger species wander far from their original home, and are not rarely found at distant localities as occasional visitors. Thus the "Maigre" (*Sciæna aquila*) reaches sometimes the British coasts, and has been found at the Cape of Good Hope and on the coast of Southern Australia. Large specimens of allied species (*S. antarctica*, *S. diacanthus*) are exhibited in table-cases. To this family also belong the Umbrine (*Umbrina*) and the "Drum" (*Pogonias*). The latter derives its name from the extraordinary sounds which it produces. These sounds are better expressed by the word "drumming" than by any other, and are frequently noticed by persons in vessels lying at anchor on the coast of the United States, where these fishes abound. It is still a matter of uncertainty by what means the "Drum" produces the sounds. Some naturalists believe that it is caused by the clapping together of the pharyngeal teeth, which are very large molar teeth. However, if it be true that the sounds are accompanied by a tremulous motion of the vessel, it seems more probable that they are produced by the fishes beating their tails against the bottom of the vessel in order to get rid of the parasites with which that part of their body is infested.

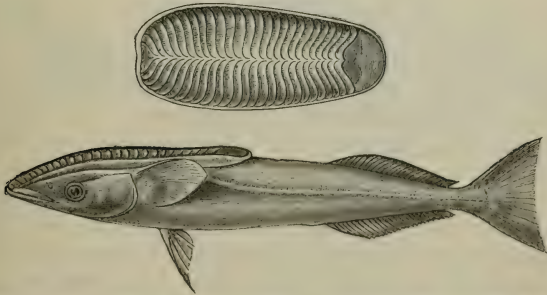
Allied to the preceding family are the *Polynemidae* (Case 9), characterized by the free filaments which are inserted on the humeral arch at some distance from the pectoral fin, of which, however, they form merely a detached portion. They can be moved quite independently and are organs of touch. The Polynemoids are very useful to man; their flesh is esteemed, and some of the species are provided with an air-bladder which yields a good sort of isinglass; specimens of this important article of trade are exhibited. These fishes belong to the littoral fauna of the Tropics, and some attain to a length of four feet.

The family of *Sphyrænidæ* (Case 9 and Table-case) consist of one genus only, *Sphyræna*, generally called "Barracudas," large voracious fishes from the tropical and subtropical seas. They attain to

a length of eight feet and a weight of 40 lb.; individuals of this large size are dangerous to bathers. They are generally used as food, but sometimes (especially in the West Indies) their flesh assumes poisonous qualities, in consequence of their feeding on smaller poisonous fishes, particularly certain Clupeoids.

The *Scombridæ*, or Mackerel family (Cases 10, 11), are pelagic [Case 10.] forms, abundant in all the seas of the tropical and temperate zones. They are one of the four families of fishes which are the most useful to man, the others being the Gadoids, Clupeoids, and Salmonoids. They are fishes of prey and are unceasingly active, their power of endurance in swimming being equal to the rapidity of their motions. They wander about in shoals, spawn in the open sea, but periodically approach the shore, probably in the pursuit of other fishes on which they feed. The type of this family is the Common Mackerel (*Scomber scomber*). The Tunny (*Thynnus thynnus*), abundant in the Mediterranean, and ranging to the south coast of England and to Tasmania, is one of the largest fishes of the Ocean, attaining to a length of 10 feet and to a weight of more than 1000 pounds. The fishery of the Tunny is systematically carried on in the Mediterranean. To the same genus belongs the Albacore (*T. albacora*). Specimens of both these species are exhibited in a separate table-case. Other highly esteemed fishes [Case 11.] of this family are the "John Dorys" (*Zeus*). The remarkable Sucking-fishes (*Echeneis*) have the spinous dorsal fin modified into

Fig. 48.

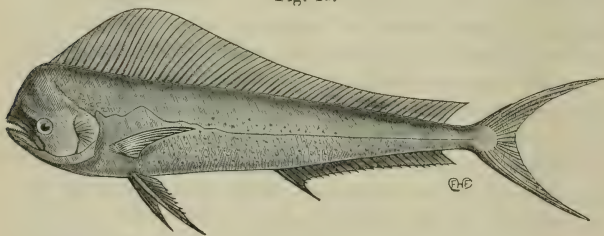


Sucking-fish (*Echeneis scutata*); with separate view of sucking-disk.  
(Indian Ocean.)



an adhesive disk, which occupies the upperside of the head and neck. These fishes, of which ten different species are known, are enabled to attach themselves to any flat surface by means of this disk. The adhesion is so strong that the fish can only be dislodged with difficulty, unless it is pushed forwards by a sliding motion. They attach themselves to sharks, turtles, ships, or any other object which serves their purpose, and, being bad swimmers, they allow themselves to be thus carried about by other animals endowed with a greater power of locomotion or by vessels. This genus is connected with the more normal forms of this family through *Elacate*, which, though closely allied to the Sucking-fish, have the spinous dorsal fin formed of free spines. *Coryphæna*, generally (though by misapplication of the name) called "Dolphins," are pelagic fishes,

Fig. 49.

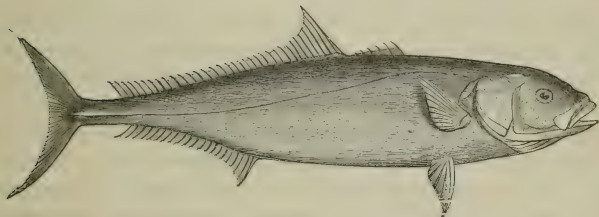
Dolphin (*Coryphæna hippurus*). (From the Atlantic Ocean.)

distributed over all the tropical and subtropical seas; they are most powerful swimmers, congregate in shoals, and pursue the Flying-fish, which try to escape their enemies by long flying leaps. They attain to a length of 6 feet, and are eagerly caught by sailors on account of their well-flavoured flesh. The beauty of their, unfortunately fugitive, colours has ever been a subject of admiration. The Opah or King-fish (*Lampris luna*) is one of the most beautiful fishes of the Atlantic, and occasionally occurs on the British coast. It attains to a length of four feet. The skeleton (of which a specimen, together with a stuffed example, is exhibited in a table-case) exhibits several peculiarities, viz., an extraordinary development and dilatation of the humeral arch, and great strength of the numerous and closely-set ribs.



The *Carangidæ* (Cases 12, 13), or Horse-Mackerels, are a large [Case 12.] family of carnivorous fishes allied to the true Mackerels, and inhabiting the tropical and temperate seas. One species (*Caranx trachurus*) is common on our coasts, and almost cosmopolitan within the temperate and tropical zones of the northern and southern hemispheres. The "Yellow-tails" (*Seriola*) occur in

Fig. 50.

Yellow-tail (*Seriola lalandii*). (From South Australia.)

all the temperate and tropical seas; the larger grow to a length of from four to five feet, and are esteemed as food. The Pilot-fish (*Naucrates ductor*) is so named from its habit of keeping

Fig. 51.

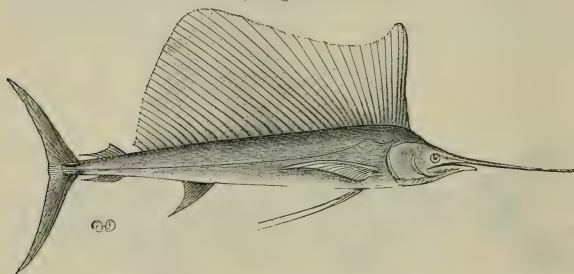
Pilot-fish (*Naucrates ductor*).

company with ships and large fish, especially Sharks. The connection between the Shark and the Pilot-fish has received various interpretations; being a small fish, it obtains greater security when in company of a Shark, which would keep at a distance all

other fishes of prey that would be likely to prove dangerous to the Pilot. With regard to the statement that the Pilot itself is never attacked by the Shark, all observers agree as to its truth; but this may be accounted for in the same way as the impunity of the swallow from the hawk, the Pilot-fish being too nimble for the unwieldy Shark. The Sea-bats (*Platux*), so called from the extraordinary length of their dorsal and anal fins and of their ventrals, are also remarkable members of this family.

[Case 13.] The *Xiphiidæ*, or Sword-fishes (Case 13), are pelagic fishes, occurring in all tropical and subtropical seas. Several large specimens are exhibited on the top of Cases 1-12, and skeletons in a Case in the centre of the Gallery. The Mediterranean Sword-fish (*Xiphias gladius*), the flesh of which is considered to be superior to that of the Tunny, and which is also abundant in the Atlantic, is the object of a regular and profitable fishery, both in Europe and America. The other species, which are found in the open ocean, and endowed with extraordinary strength and swimming powers, are less frequently captured, and still more rarely preserved. They belong to the genus *Histiophorus*, which is distinguished from

Fig. 52.



Sword-fish of the Indian and Atlantic Oceans (*Histiophorus gladius*).

the common Mediterranean Sword-fish, or *Xiphias gladius*, by the presence of ventral fins, which, however, are reduced to two long styliform appendages. Some species have the dorsal rays exceedingly elongate, so that the fin, when erected, projects beyond the surface of the water: it is stated that these Sword-fishes, when quietly floating with the dorsal fin erect, can sail before the wind

like a boat. Sword-fishes are the largest of Acanthopterygians, [Case 13.] and not exceeded in size by any other Teleostean; they attain to a length of from 12 to 15 feet, and swords have been obtained more than three feet long, and with a diameter of at least three inches at the base. This sword forms a most powerful weapon. Sword-fishes never hesitate to attack large Whales, and after repeatedly stabbing these animals they generally retire from the combat victorious. The cause which excites them to these attacks is unknown; but they follow this instinct so blindly that they not rarely attack boats or large vessels in a similar manner, evidently mistaking them for Cetaceans. Sometimes they actually succeed in piercing the bottom of a ship, endangering its safety; but, as they are unable to execute powerful backward movements, they cannot disengage their sword, which is broken off by the exertions of the fish to free itself. A piece of a two-inch plank of a whale-boat, thus pierced by a Sword-fish, in which the broken sword still remains, is exhibited, as well as a second block

Fig. 53.



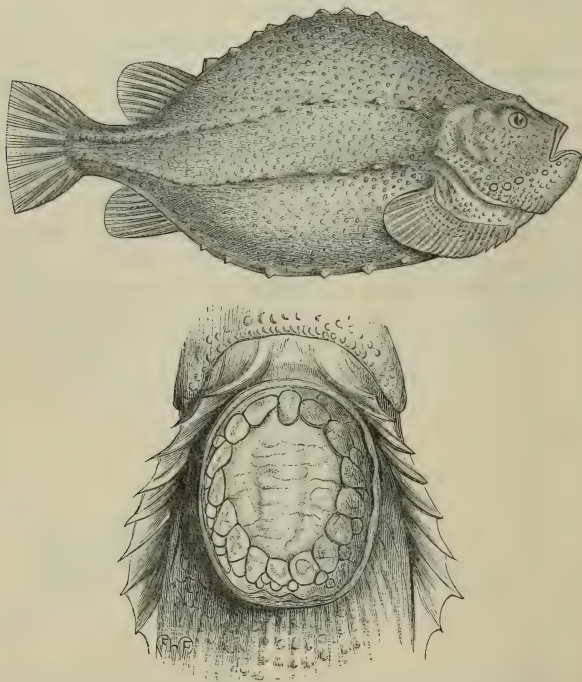
Block of wood pierced by Sword-fishes.

of wood, from a ship, pierced by three swords. Attacks by small Sword-fishes on the frail canoes of the natives of the South-Sea Islands or on the stronger boats of the professional Sword-fish hunters are of common occurrence, and only too often the persons sitting in them are dangerously wounded.

The *Gobiidae* and *Discoboli* (Case 13) are two closely allied families in which the ventral fins are usually united to form an adhesive disk. The former contains numerous species, small

[Case 13.] carnivorous littoral fishes, many of which have become acclimatized in fresh water. It is represented in British waters by several species of *Gobius* and two of *Callionymus* (Dragonet). The latter family contains the Lump-suckers (*Cyclopterus*), the

Fig. 54.



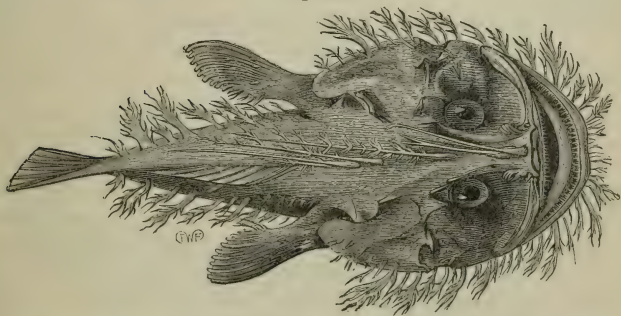
Lump-sucker (*Cyclopterus lumpus*) ; with a separate view of the sucking-disk.

common species (*C. lumpus*) occurring in North Europe and North America. It is difficult to remove it from any object to which it has once attached itself by means of its sucking-disk.

The *Pediculati* or Sea-devils (Case 13) contain a larger number of bizarre forms than any other ; and there is, perhaps, none in

which the singular organization of the fish is more distinctly seen [Case 13.] to be in consonance with its habits. Pediculates are found in all seas. The habits of all are equally sluggish and inactive: they are very bad swimmers; those found near the coasts lie on the bottom of the sea, holding on with their arm-like pectoral fins to seaweed or stones, between which they are hidden; those of pelagic habits attach themselves to floating seaweed or other objects, and are at the mercy of the wind and current. A large proportion of the genera, therefore, have gradually found their way to the greatest depths of the ocean—retaining all the characteristics of their surface-ancestors, but assuming the modifications by which they are enabled to live in abyssal depths. The Fishing-frogs (*Lophius*), also called Anglers or Sea-devils, are coast-fishes,

Fig. 55.



Angler, or Sea-devil (*Lophius naresii*). (From the Admiralty Islands.)

living at small depths. The wide mouth extends all round the anterior circumference of the head, and both jaws are armed with bands of long pointed teeth, which are inclined inwards, and can be depressed so as to offer no impediment to an object gliding towards the stomach, but prevent its escape from the mouth. The pectoral and ventral fins are so articulated as to perform the functions of feet, the fish being enabled to move, or rather to walk, on the bottom of the sea, where it generally hides itself in the sand or amongst seaweed. All round its head, and also along the body, the skin bears fringed appendages, resembling



[Case 13.] short fronds of seaweed—a structure which, combined with the extraordinary faculty of assimilating the colours of the body to its surroundings, assists the fish in concealing itself in places which it selects on account of the abundance of prey. To render the organization of these creatures perfect in relation to their wants, they are provided with three long filaments inserted along the middle of the head, which are, in fact, the detached and modified first three spines of the anterior dorsal fin. The filament most important in the economy of the Fishing-frogs is the first, which is the longest, terminates in a lappet, and is movable in every direction. There is no doubt that the Fishing-frog, like many other fish provided with similar appendages, plays with this filament as with a bait, attracting fishes, which, when sufficiently near, are engulfed by the simple act of the Fishing-frog opening its gape. It is extremely interesting to find that in Fishing-frogs inhabiting great depths of the ocean, to which no ray of light can penetrate, the filament is provided at its end with a luminous or phosphorescent organ; the light issuing from it attracts other creatures, in the same manner as surface-animals congregate round the lamp of a boat during a dark night. The stomach of the Sea-devil is distensible in an extraordinary degree, and not rarely fishes have been taken out of it quite as large and heavy as their destroyer. The British species (*L. piscatorius*) grows to a length of more than five feet; an allied species from the Admiralty Islands (*Lophius naresii*) is figured here. *Chaunax nictus* is a deep-sea form, hitherto found near Madeira, Japan, and the Fiji Islands, at a depth of 215 fathoms. Another curious fish of this family is *Malthe vespertilio*, common on the shores of the tropical Atlantic; the anterior part of the snout is produced into a long process, beneath which there is a retractile tentacle.

The *Blenniidae*, or Blennies (Case 13), are mostly small-sized littoral fishes; some species have become acclimatized in fresh water, and many inhabit brackish water. Four species of *Blennius* occur on the British coasts. The Sea-wolf or Sea-cat (*Anarrhichas lupus*) is a gigantic Blenny, attaining to a length of more than six feet. With its enormously strong tubercular teeth it is able to crush the hardest shells of crustaceans or mollusks, on which it feeds voraciously. It is an inhabitant of



Fig. 56.

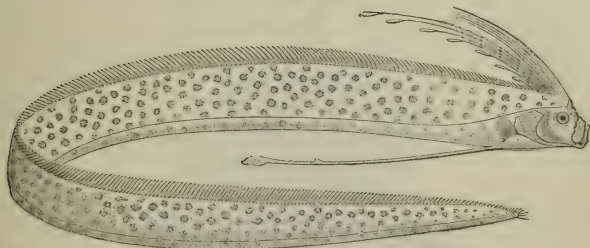
[Case 13.]

Sea-wolf (*Anarrhichas lupus*).

the northern seas, occurring plentifully on our northern coasts. Of late years it is frequently to be seen in the London market, its flesh being firm and well-flavoured. A stuffed specimen and skeleton are exhibited in a table-case.

The *Trachypteridæ*, or Ribbon-fishes, are true deep-sea fishes, met with in all parts of the oceans, generally found when floating dead on the surface or thrown ashore by the waves. Their body

Fig. 57.

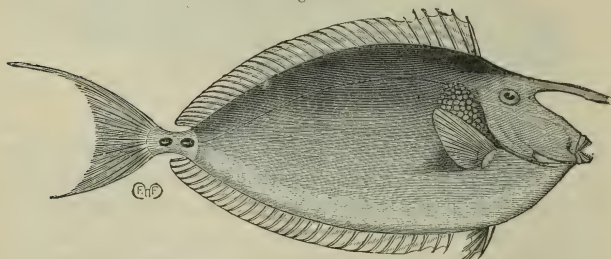
Ribbon-fish (*Regalecus gladius*).

is like a band, specimens of from 15 to 20 feet long being 10 to 12 inches deep, and about an inch or two broad at their thickest part. The bones contain very little bony matter, are very porous, thin and light. A few specimens are exhibited on the top of Cases 13 and 16.

The *Acronuridæ*, or Sea-Surgeons (Case 14), are inhabitants of [Case 14.] the tropical seas, and most abundant on coral-reefs. They feed either on vegetable substances or on the superficial animal matter of corals. The best known are *Acanthurus*, readily recognized by the sharp lanceet-shaped spine with which each side of the tail is armed. When at rest the spine is hidden in a sheath; but it can

be erected and used by the fish as a very dangerous weapon, by striking with the tail towards the right and left. *Naseus*,

Fig. 58.

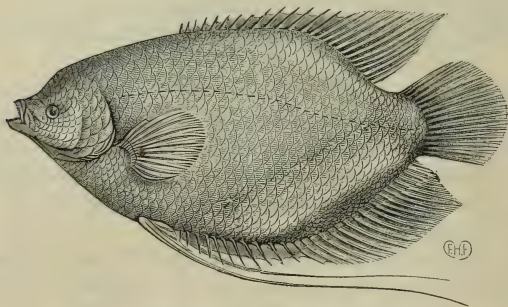


*Naseus unicornis*. (From the Indo-Pacific Ocean.)

remarkable for the horn-like projection on its forehead, also belongs to this family.

The *Labyrinthici* (Case 14) are freshwater fishes of Tropical Africa and the East Indies. They are able to live for some time out of water, or in thick or hardened mud. In an accessory branchial cavity there is lodged a laminated organ which has the function of assisting in the oxygenization of the blood. The Climbing-Perch (*Anabas scandens*) is well known for its faculty

Fig. 59.



Gourami (*Osphromenus olfax*).

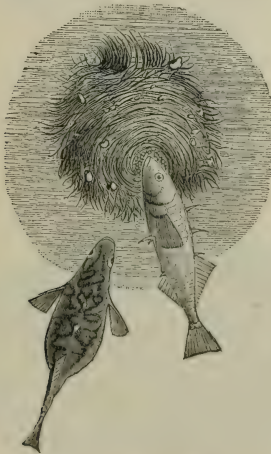
of moving for some distance over land, and even of ascending trees. The Gourami (*Osphromenus olfax*) is reputed to be one

of the best-flavoured freshwater fishes of the East-Indian Archipelago. [Case 14.] Being an almost omnivorous fish and tenacious of life, it seems to recommend itself particularly for acclimatization in other tropical countries, and specimens kept in captivity become as tame as Carp.

The *Mugilidæ*, or Grey Mulletts (Case 14), are characterized by a more or less oblong and compressed body, covered with cycloid scales of moderate size, by the absence of a lateral line, and by their anterior dorsal fin being composed of four stiff spines. They inhabit, in numerous species and in great numbers, the coasts of the temperate and tropical zones. They frequent brackish waters, in which they find an abundance of food, which consists chiefly of organic substances mixed with mud or sand. Several species are more or less abundant on the British coasts.

The *Gastrosteidæ*, or Sticklebacks (Case 14), are small fishes with elongate, compressed body, without scales, but generally with large

Fig. 60.



Stickleback and Nest.

scutes along the side, and parts of the skeleton forming an incomplete external mail. The ventral fins are abdominal, articulated

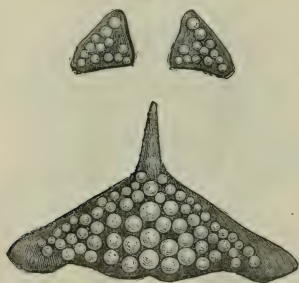
[Case 14.] to the pubic bone, and composed of a spine and a small ray. The spines of the anterior dorsal are isolated. Three species are common in the British Isles, and are very remarkable for the elegant nests they construct. The three-spined and ten-spined Sticklebacks (*Gastrosteus aculeatus* and *pungitius*) are inhabitants of the fresh and brackish waters; the larger, or fifteen-spined, species (*G. spinachia*) is marine, and abundant in brackish water.

The *Fistulariidae*, or Flute-mouths (Case 14), are gigantic marine Sticklebacks, living near the shore. They are distributed over the whole of the tropical and subtropical parts of the Atlantic and Indo-Pacific. The species are few in number.

## Order II. PHARYNGOGNATHI.

Acanthopterygians with the lower pharyngeal bones coalescent. They are divided into four families:—1. *Pomacentridæ*. 2. *Labridæ*. 3. *Embiotocidæ*. 4. *Chromides*.

Fig. 61.



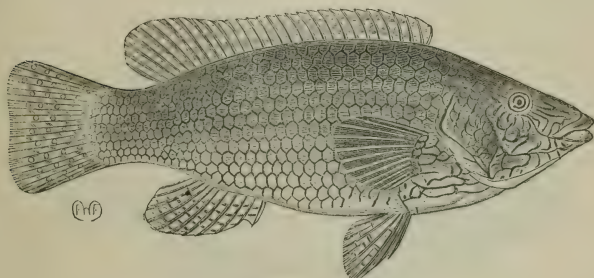
Separate upper and united lower pharyngeal bones of *Labrus maculatus*.

The *Pomacentridæ* are small marine fishes, resembling the Chætodonts with regard to their geographical distribution, mode of life, and coloration.

The *Labridæ*, or Wrasses (Cases 14, 15), are a large family of littoral fishes, very abundant in the temperate and tropical zones, but becoming scarcer towards the Arctic and Antarctic circles, where they disappear entirely. Many of them are readily recognized by

their thick lips, which are sometimes internally folded, a peculiarity which has given to them the German term of "Lip-fishes." They feed chiefly on mollusks and crustaceans, their dentition being admirably adapted for crushing hard substances. Others feed on corals, echinoderms, etc.; a few are herbivorous. Nearly all are distinguished by their beautiful coloration, and some of the species are, perhaps, the most gorgeously coloured in the whole class of Fishes. Several species occur on the British coasts, belonging to

Fig. 62.

Wrasse (*Labrus maculatus*).

the genera *Labrus*, *Crenilabrus*, *Otenolabrus*, *Acantholabrus*, *Centrolabrus*, and *Coris*. The Parrot-Wrasses (*Scarus* and *Pseudoscarus*)

Fig. 63.

Wrasse (*Pseudoscarus troschelii*). (From the Indian Ocean.)

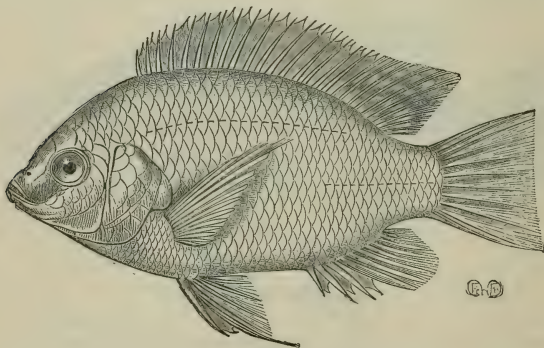


are chiefly tropical fishes, which have the jaws transformed into a hard beak, the teeth being soldered together.

The *Embiotocidæ* are marine fishes characteristic of the fauna of the temperate North Pacific, the majority living on the American side, and only a few on the Asiatic. They are viviparous.

The *Chromides* are freshwater fishes of rather small size, from the tropical parts of Africa and America. Some are herbivorous,

Fig. 64.



"Bulti" of the Nile (*Chromis niloticus*).

the others carnivorous. *Chromis niloticus*, the "Bulti" or "Bolti" of the Nile, is one of the few well-flavoured fishes of that river. Several species are common in Lake Tiberias.

### Order III. ANACANTHINI.

Bony fishes without spinous rays in the vertical and ventral fins; the air-bladder, if present, without pneumatic duct, and the ventral fins, if present, jugular or thoracic.

They form two divisions, viz. the *Gadoidæi* (Cod-fishes), in which the head and body are symmetrically formed; and the *Pleuronectoidei* (Flat-fishes), in which the head and part of the body are unsymmetrical. The former group contains four families:—*Iycodidæ*, *Gadidæ*, *Ophidiidæ*, and *Macruridæ*; the latter includes a single family only—*Pleuronectidæ*.



The *Gadidæ*, or Cod-fishes (Case 17), consist partly of littoral [Case 17.] and surface species, partly of deep-sea forms. The former are almost entirely confined to the temperate zones, extending northwards beyond the Arctic circle; the latter have, as deep-sea fishes generally, a much wider range, and hitherto have been found chiefly at considerable depths in rather low latitudes. Only two or three species inhabit fresh waters. Cod-fishes form one of the most important articles of food and subsistence to the fishermen in Europe and North America, and to whole tribes bordering upon the Arctic Ocean. The common Cod (*Gadus morrhua*) measures from two to four feet, and attains to a weight of one hundred pounds. It occurs between 50° and 75° N. lat., in great abundance, to a depth of 120 fathoms, but is not found nearer the Equator than 40° lat. It is met with singly all the year round close to the coast, but towards the spawning-time it approaches the shore or shallow banks in numbers; this happens in January in England, and not before May on the American coasts. The English resorted to the Cod-fisheries of Iceland before the year 1415; but since the sixteenth century most vessels go to the Banks of Newfoundland, and almost all the preserved Cod consumed during Lent in the various continental countries is imported from across the Atlantic. At one time the Newfoundland Cod-fishery rivalled in importance the Whale-fishery and the Fur-trade of North America. Cod-liver oil is prepared from the liver of the common Cod on the Norwegian coast, but also other species of this genus contribute to this most important drug. The Haddock (*G. æglefinus*), the Whiting (*G. merlangus*), the Bib or Pout (*G. luscus*), the Power-Cod (*G. minutus*), the Pollack (*G. pollachius*), and the Coal-fish (*G. virens*) are other well-known species of the same genus. The Norway Pout (*G. esmarkii*) has recently been discovered on the west coast of Scotland. The Hake (*Merluccius vulgaris*) is also found on both sides of the Atlantic, and forms, preserved as "Stock-fish," an important article of trade. The Ling (*Molva vulgaris*), of which a stuffed specimen and skeleton are exhibited in a separate case, is likewise a very valuable species, from three to four feet long, abundant in the north of Great Britain. The Rocklings (*Onus*) are small fishes of which several species occur on the British coast. The Burbot or Eel-pout (*Lota vulgaris*, fig. 65) is a freshwater fish

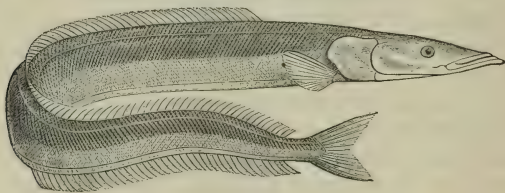
[Case 17.] which never enters salt water. It is locally distributed in Central and Northern Europe and North America; it is one of the best freshwater fishes, and exceeds a length of three feet.

Fig. 65.

The Burbot (*Lota vulgaris*).

The *Ophidiidae* are small Gadoids with more or less elongated, naked or scaly body. The "Sand-eels" or "Launces" (*Ammodytes*, fig. 66) occur on the British coast, and are well known

Fig. 66.

The Sand-eel (*Ammodytes lanceolatus*).

for the incredible rapidity with which they bury themselves in the sand; they are much sought after for bait.

The *Macruridae* (fig. 67) are deep-sea Gadoids of curious shape, occurring at depths of from 120 to 2600 fathoms. This family, known a few years ago from a few species only, proves to be one which is distributed over all oceans, occurring in considerable variety and great abundance. About 40 species are known, of which many attain a length of three feet.

The *Pleuronectidae* are called Flat-fishes, from their strongly compressed, high, and flat body. In consequence of the absence

of an air-bladder, and of the structure of their paired fins, [Case 17.] they are unable to maintain their body in a vertical position, resting and moving on one side only. The side turned towards

Fig. 67.



*Macrurus parallelus* : from a depth of 350 fathoms.

the bottom is sometimes the left, sometimes the right, colourless, and termed the "blind" side ; that turned upwards and towards the light is variously, and in some tropical species even vividly, coloured. Both eyes are on the coloured side, on which side also the muscles are more strongly developed. The dorsal and anal fins are exceedingly long, without division. All the Flat-fishes undergo remarkable changes with age ; when quite young, they are perfectly symmetrical, with an eye on each side of the head, and swim in a vertical position like other fishes. To illustrate the gradual change from the symmetrical form of the newly-hatched Flat-fish to the more advanced asymmetrical shape, a series of young Brill (*Rhombus lævis*) is exhibited in Case 17. Flat-fishes when adult live always on the bottom, and swim with an undulating motion of their body. They occur in all seas, except in the highest latitudes and on rocky precipitous coasts, becoming most numerous towards the Equator ; those of the largest size occur in the Temperate zone. Some enter fresh water freely, and others have become entirely acclimatized in ponds and rivers. All are carnivorous. Those most generally known are:—The Holibut (*Hippoglossus vulgaris*), the largest of all Flat-fishes, attaining to a length of 5 or 6 feet, and a weight of several hundredweight ; the Turbot (*Rhombus maximus*), one of the most valued food-fishes ; the Brill (*R. lævis*) ; the Plaice (*Pleuronectes platessa*) ; the Dab (*P. limanda*) ; the Flounder (*P. flesus*) ; the Smear-Dab or Lemon-Dab (*P. microcephalus*) ; the Craig-fluke (*P. cyano-glossus*) ; and the Soles (*Solea*).

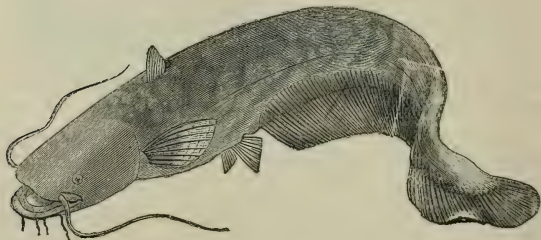
## Order IV. PHYSOSTOMI.

[Case 18.] Bony fishes with all the fin-rays articulated, only the first of the dorsal and pectoral fins sometimes ossified; ventral fins, if present, abdominal, without spine. Air-bladder, if present, with a pneumatic duct (except in *Scombresocidæ*). 29 families:—

1. *Siluridæ*. 2. *Characinidæ*. 3. *Cyprinidæ*. 4. *Haplochitonidæ*. 5. *Sternoptychidæ*. 6. *Scopelidæ*. 7. *Stomiatidæ*. 8. *Salmonidæ*. 9. *Percopsidæ*. 10. *Galaxiidæ*. 11. *Mormyridæ*. 12. *Esocidæ*. 13. *Umbridæ*. 14. *Scombresocidæ*. 15. *Cyprinodontidæ*. 16. *Heteropygii*. 17. *Gonorhynchidæ*. 18. *Hyodontidæ*. 19. *Osteoglossidæ*. 20. *Clupeidæ*. 21. *Chirocentridæ*. 22. *Bathythrissidæ*. 23. *Alepocephalidæ*. 24. *Notopteridæ*. 25. *Halosauridæ*. 26. *Notacanthidæ*. 27. *Gymnotidæ*. 28. *Symbranchidæ*. 29. *Muraenidæ*.

The *Siluridæ*, or Cat-fishes (Cases 18, 19), are a large family, represented by numerous genera, which exhibit a great variety of form and structure of the fins. The skin is naked or protected by osseous scutes, but without scales; barbels are generally present. These fish inhabit the fresh waters of all the temperate and tropical regions; a few only enter the sea, but keep near the coast. The European species (*Silurus glanis*, fig. 68) is found in the

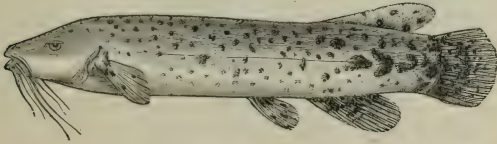
Fig. 68.

Wels (*Silurus glanis*).

waters east of the Rhine, and is, next to the Sturgeon, the largest of European freshwater fishes, attaining to a weight of 300 or 400 lb. The "Bayad" (*Bagrus bayad*) is common in the Nile, and grows to a length of over five feet; it is eaten. *Arius*, of

which numerous species are known, has a wide distribution, being [Case 18.] found in almost all tropical countries which are drained by large rivers; some of the species prefer brackish to fresh water, and a few enter the sea. *Arius latiscutatus*, from West Africa, is one of the largest species of this genus. *Pimelodus*, common in South America, also includes some very large species. The Electric Cat-fish (*Malapterurus*, fig. 69) occurs in Tropical

Fig. 69.

Electric Cat-fish (*Malapterurus*). (From Tropical Africa.)

Africa, and grows to a length of about four feet. The electric organ extends over the whole of the body, but is thickest on the abdomen. The *Callichthys* of Tropical America (fig. 70) have the

Fig. 70.

*Callichthys*. (From British Guiana.)

body wholly protected by two series of large imbricate shields on each side; they construct nests for their ova. The species of *Aspredo* are inhabitants of the Guianas, and remarkable for their mode of carrying their ova: after having deposited the eggs, the female attaches them to, and presses them into, the spongy integument of her belly by merely lying over them, and carries them until they are hatched.



[Case 20.] The *Characinidæ* (Case 20) are confined to the fresh waters of Africa and tropical America. This family includes herbivorous as well as strictly carnivorous forms; some are toothless, whilst others possess a most formidable dentition. Many are provided with an adipose dorsal fin, like the *Salmonidæ* and some *Siluridæ*. Among the carnivorous forms, *Myletes* (Caribe) and *Hydrocyon* are most destructive to other fishes, and are known to attack and annoy even bathers.

[Case 22 a, in the passage from Central Hall to Fish Gallery.]

The *Cyprinidæ*, or family of Carps (Case 22 a), is the most numerous represented in the fresh waters of the Old World and North America. Most feed on vegetable and animal substances; a few only are exclusively vegetable-feeders. The absence of teeth in the jaws is compensated by the development of large teeth on the pharyngeal bones. The Carp (*Cyprinus carpio*), originally a

Fig. 71.

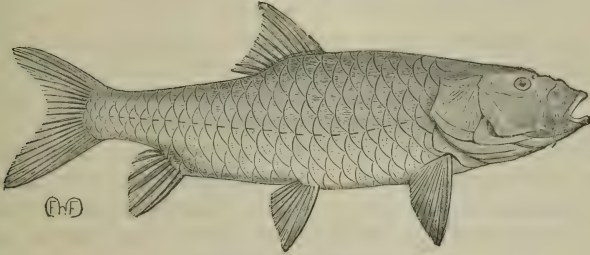


Pharyngeal bones and side-view of one of the teeth of the Chub.

native of the East, abounds in a wild state in China, where it has been domesticated for many centuries; thence it was transported to Germany and Sweden, and the year 1614 is assigned as the date of its introduction into England. Two allied and common species are the Crucian Carp (*C. carassius*) and the Gold-fish (*C. auratus*). The Catla of the Ganges (*Catla buehanani*) is one of the largest Cyprinoids, growing to a length of more than three feet, and esteemed as food. The Barbels (*Barbus*) are a genus very numerous in species, inhabiting the temperate and tropical parts of the Old World; one species is British (*B. vulgaris*); *B. mosal*, or "Mahaseer" (fig. 72) of the mountain-streams of India, is probably the largest species of the genus, the scales being sometimes as large as the palm of the hand. The White-fish (*Leuciscus*) are also

extremely numerous in species in the Old and New Worlds, of which the following are well known in England:—The Roach (*L. rutilus*), the Chub (*L. cephalus*), the Dace (*L. leuciscus*), the

Fig. 72.

Mahaseer (*Barbus mosal*).

Rudd (*L. erythrophthalmus*), and the Minnow (*L. phoxinus*). Other British Cyprinoids are the Tench (*Tinca tinca*), the Bleak (*Alburnus alburnus*), the Breams (*Abramis brama* and *blicca*), and the Loaches (*Nemachilus barbatulus* and *Cobitis tænia*).

The *Haplochitonidæ* are a small but interesting family, inasmuch as they represent the Salmonoids in the temperate parts of the Southern Hemisphere. They differ from the latter family in the structure of the jaws, and by the total absence of pyloric appendages; but they possess an adipose fin like the Salmonoids. Two genera are known: one, *Haplochiton*, is abundant in the lakes and streams of the Falkland Islands, Patagonia, and Chili; these fishes have the general appearance of a Trout, but are naked. The second genus, *Prototroctes*, is scaly, and resembles a Vendace (*Coregonus*); the settlers of South Australia and New Zealand call them Grayling.

The *Salmonidæ* (Case 21) are one of the most valuable families [Case 21.] of the Class of Fishes. They are inhabitants of the sea and fresh water; but the majority of the marine genera are deep-sea forms. The freshwater forms are peculiar to the Temperate and Arctic zones of the Northern Hemisphere, one only (a Smelt) occurring in New Zealand. Many migrate periodically or occasionally from fresh water to the sea, or *vice versâ*. The genus *Salmo*, containing the Salmon, Trout, and Char, is abundant in species, some being

migratory, others not ; they are spread over the whole of Europe and North America.

Of the species exhibited attention is directed especially to the following:—the Lake-Wenern Trout (*Salmo venernensis*), a non-migratory species ; a large Sea-Trout from the River Narenta, Dalmatia (*S. dentex*) ; two male British Sea-Trout (*S. trutta*) with extraordinary development of the jaws ; a large specimen of the Alpine Char (*S. alpinus*) from Nova Zembla ; the Brook-Trout of North America (*S. fontinalis* and *S. hoodii*). The Common Trout (*S. fario*) has been successfully introduced in rivers and lakes of Tasmania and New Zealand, where it grows to a size rivalling that of the Sea-Trout and Salmon, finding at present an abundance of nourishing food in the small native fish (especially *Galaxias*), which in the course of time will be brought to the verge of extinction. In a tank on a table-case between wall-cases 17 and 18 a beautiful large specimen of a Trout (*S. fario*) is exhibited, which has been reared in New Zealand, and was captured in the estuary of the River Waimakariri ; in its size it is quite equal to the large Trout sometimes found in the River Thames, which it also resembles in general appearance. The Smelt (*Osmerus eperlanus*) ; the Vendace, called White-fish in North America (*Coregonus*, fig. 73), numerous in

Fig. 73.



Vendace (*Coregonus vandesius*). (From Loch Maben.)

species in Europe and North America, and the Graylings (*Thymallus*) are other well-known and highly esteemed members of this family.

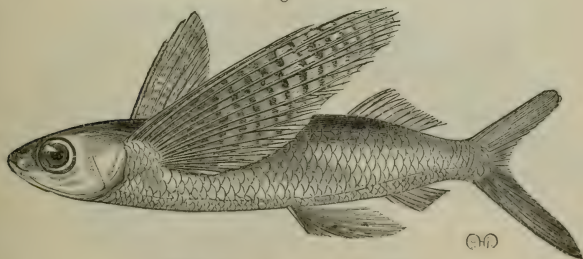
The *Galaxiidae* resemble the Pike in the disposition of their fins but are confined to freshwaters of Temperate Australia, Tasmania,

New Zealand, and of the southern extremity of South America. They are scaleless. The number of species is small, but in Tasmania and New Zealand they form almost the whole of the Fresh-water-Fish fauna. They rarely exceed a length of eight inches, but are well-flavoured. The fry is eaten in New Zealand, and known as "White-bait."

The *Mormyridæ* (Case 22) are a type peculiar to the fresh waters of tropical Africa. The genus *Mormyrus* is numerous in species, some of which attain to a length of four feet. Many are remarkable for their long and decurved snout. The common species of the Nile (*Mormyrus oxyrhynchus*) was an object of veneration to the ancient Egyptians, and therefore frequently occurs in their emblematic inscriptions. Another member of this family is *Gymnarchus niloticus*, of eel-like habit and growing to a length of six feet.

The *Esocidæ* (Case 22), or Pike, are inhabitants of the fresh waters of the temperate parts of Europe, Asia, and America. The European species (*E. lucius*) inhabits all three continents. Very large specimens are called "Muskellonge" in America. An old painting of a large Pike is exhibited, which, according to the legend, was caught in the year 1230 by the Emperor Frederick II., marked with an inscribed ring, and caught again after the lapse of more than two centuries.

Fig. 74.

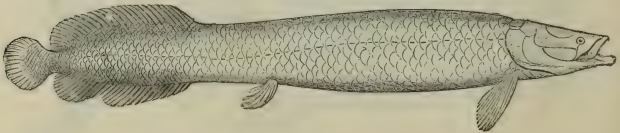
Flying-fish (*Exocoetus spilopterus*).

The *Scombresocidæ* (Case 22) are chiefly marine. The Gar-pike (*Belone*) have both jaws prolonged into a long slender beak. The most curious members of this family are the Flying-fishes (*Exocoetus*, fig. 74), of which numerous species are known from tropical

and subtropical seas. Their usual length is about 10 or 12 inches, but specimens of 18 inches have been caught. They are enabled to execute flying leaps by means of the great development of their pectoral fins. They dart out of the water when pursued by their enemies, or frightened by an approaching vessel, but frequently also without any apparent cause, as is also observed in many other fishes; they rise without regard to the direction of the wind or waves. During flight the fins are kept quietly distended, without any motion, except an occasional vibration caused by the air whenever the surface of the wing is parallel with the current of the wind. Their flight is rapid, greatly exceeding that of a ship going 10 miles an hour, but gradually decreasing in velocity, and rarely extending beyond a distance of 500 feet. Flying-fishes often fall on board of vessels; but this never happens during a calm, or from the lee side, but during a breeze only, and from the weather side.

[Case 22 a, in passage from Central Hall to Fish Gallery.] The *Osteoglossidæ* (Case 22 b) are large freshwater fishes of the tropics. Of the genus *Osteoglossum* three species are known—one from Brazil and the Guianas, one from Borneo and Sumatra, and the third from Queensland. The single species of the genus *Heterotis* (*H. niloticus*) is not uncommon in the Upper Nile and the West-African rivers. The genus *Arapaima* (fig. 75) also contains a single species, *A. gigas* (exhibited in separate table-cases), from the rivers of Brazil and the Guianas, and highly esteemed as an article of food. It is the largest freshwater Teleostean known, exceeding a length of 15 feet, and a weight of 400 lb.

Fig. 75.

*Arapaima* of the River Amazon.

[Case 22 a.] The *Clupeidæ*, or Herrings (Case 22 b), are probably unsurpassed by any other family in the number of individuals, although others comprise a much greater variety of species. The Herrings are principally coast-fishes; none belong to the deep-sea fauna;



scarcely any have pelagic habits, but many enter or live in fresh waters communicating with the sea. They are spread over all the temperate and tropical seas. The genus of Herrings proper (*Clupea*) includes more than sixty species, of which several are extremely common on our coasts, viz. the Herring (*Clupea harengus*) of immense commercial value, the Sprat (*C. sprattus*), the Shad (*C. alosa* and *C. finta*), and the Pilchard or Sardine (*C. pilchardus*). The "Mossbanker" (*C. menhaden*) is common on the Atlantic coasts of the United States. The economic value of this fish is surpassed in America only by that of the Gadoids, and derived chiefly from its use as bait for other fishes, and from the oil extracted from it. *Albula* and *Elops* reach a size of three feet, but are not esteemed as food. The largest species of the whole family is the Tarpon (*Megalops thrissoides*) [a specimen of which is exhibited on the top of the case], from the Tropical Atlantic, exceeding a length of five feet, and excellent eating.

The *Chirocentridæ* and *Notopteridæ* (Case 22 *b*) are small families, inhabiting, the former the Indian Ocean, the latter fresh waters of the East Indies and West Africa.

[Case  
22 *a*.]

The *Gymnotidæ* (Case 22 *a*) are eel-like freshwater fishes from Tropical America, of which the best known is the Electric Eel (*Gymnotus electricus*, fig. 76); it is the most powerful of electric

Fig. 76.



Electric Eel (*Gymnotus electricus*).

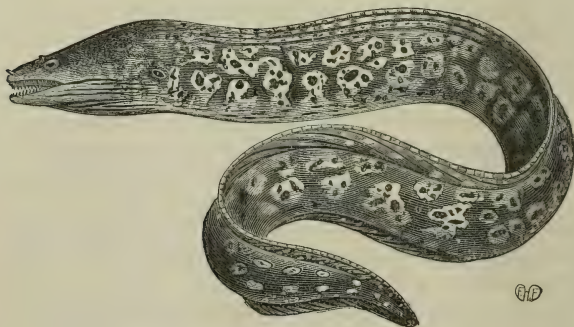
fishes, growing to a length of six feet, and extremely abundant in certain localities of Brazil and the Guianas. The electric organ

consists of two pairs of longitudinal bodies, situated immediately below the skin, above the muscles—one pair on the back of the tail and the other pair along the anal fin. The electric shock may be of sufficient strength to temporarily paralyze a man.

The Eels, *Murænidae* (Cases 23, 24), are a numerous family, spread over almost all fresh waters and seas of the temperate and

[Cases  
23, 24.]

Fig. 77.



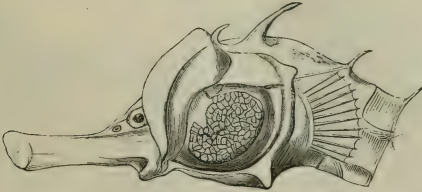
*Muræna helena.* (From the coast of Europe.)

tropical zones; some descend to the greatest depths of the oceans. Some 25 species of true Eels (*Anguilla*) are known from the fresh waters and coasts. They migrate to the sea for the purpose of breeding, and, as only recently discovered, the young undergo remarkable changes before assuming the adult condition. Two species are found in Great Britain, *A. vulgaris* and *A. latirostris*. The Congers (*Conger*) are marine Eels, differing from the preceding in the absence of scales; the common British species (*C. conger*) seems to be almost cosmopolitan. The genus *Muræna* and its allies are abundantly represented in the tropical and subtropical seas, and mostly beautifully coloured and spotted. The majority are armed with formidable pointed teeth, well suited for seizing other fish on which they prey; in shallow water they readily attack persons who happen to disturb them in their retreat. The Mediterranean species (*M. helena*, fig. 77) was highly prized by the ancient Romans.

## Order V. LOPHOBRANCHII.

The *Lophobranchii* are bony fishes in which the gills are not laminated, but composed of small rounded lobes attached to the branchial arches; the gill-cover is reduced to a large simple plate;

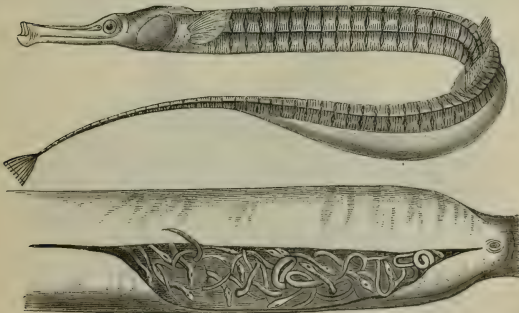
Fig. 78.

Lobular gill of *Hippocampus*.

the air-bladder is simple, without pneumatic duct; a dermal skeleton, composed of numerous pieces arranged in segments, replaces more or less soft integuments; the muscular system is not much developed; the snout is prolonged, and the mouth terminal, small, toothless, formed as in *Acanthopterygians*.

This Order (Case 27) contains only two families, *Solenostomidæ* [Case 27.

Fig. 79.

Pipe-fish (*Syngnathus acus*). (From the Cornish coast.)

The lower figure represents the pouch below the tail, opened on one side to show the young, which are ready to escape from the pouch.

and *Syngnathidæ*. They are small marine fishes, which are abundant on such parts of the coasts of tropical and temperate zones as offer

by their vegetation shelter to these defenceless creatures. They are bad swimmers, and are frequently and resistlessly carried by currents into the open ocean or to distant coasts. All enter brackish water, some fresh water. The males of most of the species carry the eggs either in a sac at the base of the tail, or attached to the abdomen. The best known are the Pipe-fishes (*Syngnathus*) and the Sea-horses (*Hippocampus*).

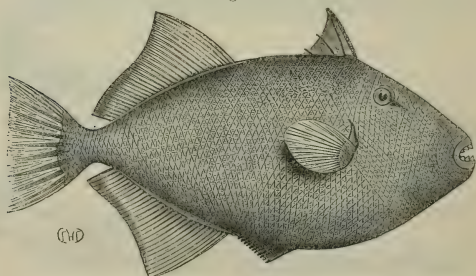
#### Order VI. PLECTOGNATHI. (Cases 25–27.)

Teleosteous fishes with rough scales, or with ossifications of the cutis in the form of scutes or spines; skin sometimes entirely naked. Skeleton incompletely ossified, with the vertebræ in small number. Gills pectinate; a narrow gill-opening in front of the pectoral fins. Mouth narrow; the bones of the upper jaw generally firmly united. A soft dorsal fin, belonging to the caudal portion of the vertebral column, opposite to the anal; sometimes elements of a spinous dorsal besides. Ventral fin none, or reduced to spines. Air-bladder without pneumatic duct.

This Order consists of two families, *Sclerodermi* and *Gymnodontes*.

The *Sclerodermi* comprise the genera *Triacanthus*, *Balistes*, *Monacanthus*, and *Ostracion*. The File-fishes (*Balistes*, fig. 80) inhabit

Fig. 80.

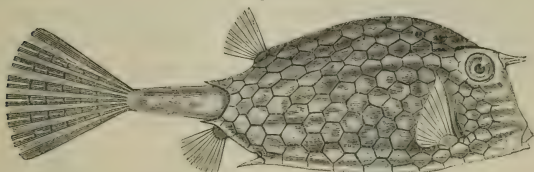


File-fish (*Balistes vidua*). (From the Indian Ocean.)

the tropical and sub-tropical seas; both jaws are armed with eight strong incisor-like and obliquely truncated teeth, by which these fishes are enabled to break off pieces of corals on which they feed, or to chisel a hole into the hard shells of Mollusca, in order to

extract the soft parts. In the sea round Ceylon they have been found to destroy an immense number of Pearl-Oysters, thus doing a great deal of injury to the fisheries. Shells pierced by File-fish are exhibited in Case 27. The Coffe-fishes (*Ostracion*) have the

Fig. 81.

Coffe-fish (*Ostracion quadricornis*). (From the West Indies.)

integuments of the body formed into a hard continuous carapace, [Case 26.] consisting of hexagonal scutes juxtaposed in mosaic fashion; only the snout, the bases of the fins, and the hind part of the tail are covered with soft skin.

Fig. 82.

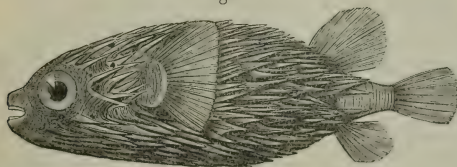


Fig. 83.

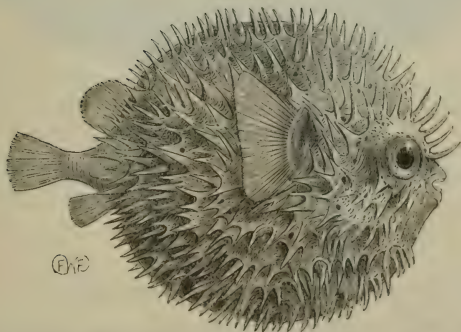
Fig. 82. Globe-fish (*Diodon maculatus*). (From the Indian Ocean.)

Fig. 83. The same, inflated.



The *Gymnodontes* contain the genera *Triodon*, *Tetrodon*, *Diodon*, and *Orthagoriscus*. The Globe-fishes (*Tetrodon* and *Diodon*) have a short, thick, cylindrical body, more or less studded with spines; they possess the power of inflating their body by filling their distensible œsophagus with air, thus assuming a more or less globular form, the spines protruding and forming a defensive armour, as in the hedgehog; therefore they are frequently called "Sea-hedgehogs."

[Case 25.] In these fish, as in the others of the same family, the bones of the

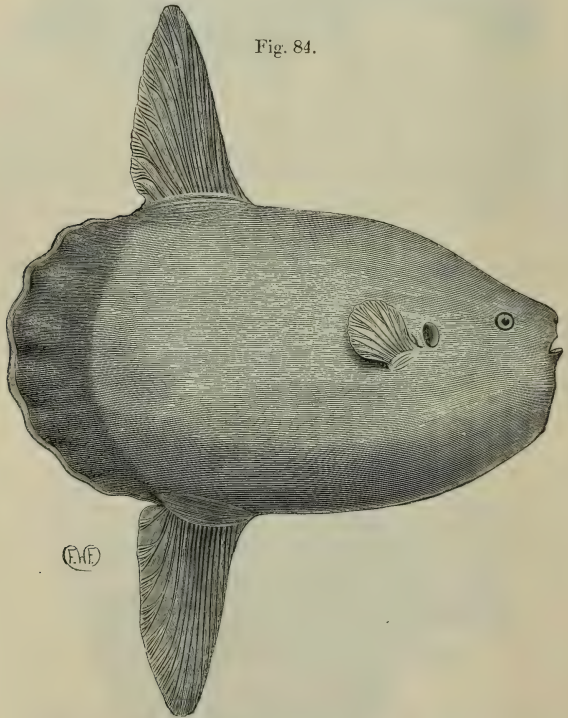


Fig. 84.

Rough Sun-fish (*Orthagoriscus mola*). (Captured near Portland.)

upper and lower jaws are confluent, forming a beak with a trenchant edge, without teeth. The Sun-fishes (*Orthagoriscus*, figs. 84, 85)

are, with regard to external form, perhaps the most singular of all Bony Fishes; they present the appearance of a fish with the tail cut off, this latter part of the body being extremely short. Two species (*O. mola* and *O. truncatus*) are known, both of which occasionally approach the southern coasts of England and Ireland. The former species, which attains to a very large size, measuring 7 or 8 feet, has a rough, minutely granulated skin. The second species is

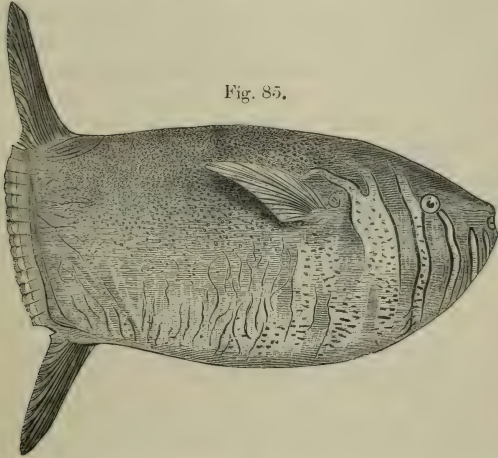


Fig. 85.

Smooth Sun-fish (*Orthogoriscus truncatus*). (From the Atlantic.)

distinguished by the more elongate form of its body, and by its smooth tessellated skin. A very large specimen of *O. mola*, from Australia, is exhibited in the Communication Gallery; a full-grown specimen of *O. truncatus* in a separate table-case.

## PALÆICHTHYES.

## Order VII. GANOIDEI.

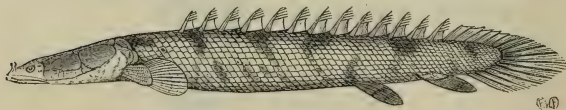
The fishes belonging to this Order have the skeleton either cartilaginous or ossified; the body is provided with median and paired fins, the hinder pair abdominal; the gills are free, rarely partially attached to the walls of the gill-cavity; one external gill-opening only on each side, and a gill-cover; the air-bladder with a pneumatic duct. The ova are small, impregnated after exclusion. The embryo or the young sometimes with external gills.

To this Order belong the majority of the fossil fish-remains of Palæozoic and Mesozoic age, whilst it is very scantily represented in the recent fauna, and evidently verging towards total extinction. Small as is the number of the surviving forms, they represent not less than five Suborders:—1. *Amioidei*. 2. *Polypteroidei*. 3. *Lepidosteoidei*. 4. *Dipnoi*. 5. *Chondrostei*.

[Case 28.] **AMIOIDEI.**—The sole living representative of this Suborder, the Mud-fish of North America (*Amia calva*), differs from the following Ganoids in being covered with cycloid scales, and approaches in its general appearance and many points of its internal structure the Teleostean type very closely indeed. The skeleton is entirely ossified. This fish is not uncommon in many of the fresh waters of the United States.

**POLYPTEROIDEI** (Case 28).—They resemble the *Lepidosteoidei* in the form and arrangement of the scales, but the structure of their

Fig. 86.

*Polypterus*. (From Tropical Africa.)

dorsal fin is quite unique; it consists of a series of dorsal spines, to each of which an articulated finlet is attached. *Polypterus* (fig. 86)

is an inhabitant of tropical Africa, occurring in abundance in the rivers of the West coast and in the Upper Nile. [Case 28.]

LEPIDOSTEOIDEI (Case 28).—The fishes of this group, as well as the following, are remarkable for the hard, bony, lozenge-shaped, polished (*ganoid*) scales with which they are covered. The skeleton is nearly completely ossified. The dorsal and anal fins are composed of articulated rays only, and placed far backwards, close to the caudal. Though the end of the body appears nearly *diphycercal* (*i. e.* with the caudal rays inserted above as well as below the vertebral axis, as in the case of most Teleosteans), the termination of the vertebral column is, in fact, distinctly *heterocercal*, as in

Fig. 87.



Gar-Pike of North America (*Lepidosteus viridis*).

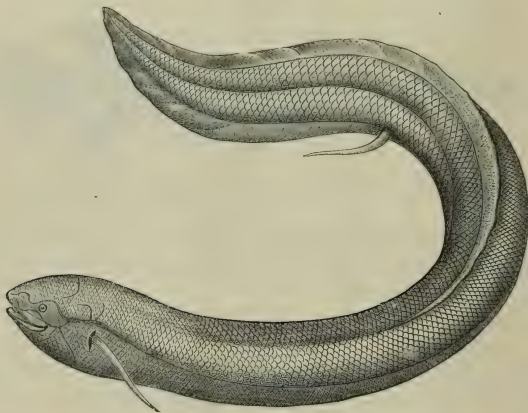
Sharks. The Gar-Pike (*Lepidosteus*, fig. 87) are at present limited to the temperate parts of North America, Central America, and Cuba. They feed on other fishes.

DIPNOI (Case 28).—The skeleton is notochordal. There are two pairs of nostrils, more or less within the mouth. Their respiratory organs are gills as well as lung-like sacs. The dentition is very peculiar; it consists of a pair of large molars, above and below, and a pair of vomerine teeth. The molars, the upper pair of which are inserted on a pterygo-palatine ossification, are provided with strong cusps or lateral prongs. The vomerine teeth are conical, pointed, or incisor-like. The fore limb differs greatly from the pectoral fin of other fishes. It is covered with small scales along the middle from the root to its extremity, and surrounded by a rayed fringe similar to the vertical fin. A muscle split into numerous fascicles extends all the length of the fin, which is flexible in every part and in every direction. The cartilaginous framework supporting it is joined to the scapular arch by an oblong cartilage, followed by a broad basal cartilage, generally single, sometimes showing traces

[Case 28.] of a triple division. Along the middle of the fin runs a jointed axis, the joints gradually becoming smaller and thinner towards the extremity; each joint bears on each side a three-, two-, or one-jointed branch. This "axial" arrangement, which evidently represents one of the first and lowest conditions of the skeleton of the limb of Vertebrates, is found in *Ceratodus* with the branches, but in *Lepidosiren* the jointed axis only has been preserved, with the addition of rudimentary rays in *Protopterus*.

Three recent genera and four species are known, viz.:—*Lepidosiren paradoxa* (fig. 88), from the Amazons and Paraguay; *Protopterus*

Fig. 88.



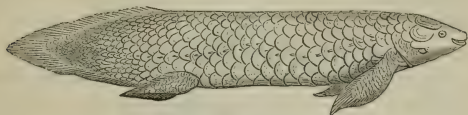
*Lepidosiren paradoxa.* (From South America.)

*annectens*, spread over the whole of tropical Africa; and *Ceratodus*, from the fresh waters of Queensland, with two species, *C. forsteri* and *C. miolepis*. *Protopterus* lives in shallow waters which periodically dry up. During the dry season they form a cavity in the mud, the inside of which is lined with a capsule of mucus, and from which they emerge again when the rains refill the pools inhabited by them. The balls of clay containing the fishes in a torpid condition are sometimes brought to Europe, and some are exhibited here. *Lepidosiren* has



recently been found in abundance in swampy localities of the Chaco, Paraguay, whence the specimen exhibited was obtained. The Barramunda (*Ceratodus*, fig. 89) is locally plentiful in the

Fig. 89.



The Barramunda (*Ceratodus*). (From Queensland.)

Burnett, Dawson, and Mary rivers, and grows to a length of six feet. To the settlers it is known by the name of Burnett or Dawson Salmon. It can breathe either by gills or by its lung alone, or by both simultaneously. Fossil teeth have long been known from Triassic and Jurassic formations in various parts of Europe, India, and America.

CHONDROSTEI (Cases 29, 30).—The skeleton is cartilaginous, and the skin is naked or partially protected by bucklers. This Suborder is divided into two families—*Acipenseridæ* and *Polyodontidæ*. To the former belong the Sturgeons (*Acipenser*), inhabitants of the temperate zone of the northern hemisphere; they are either entirely confined to fresh water, or ascend periodically, for the purpose of spawning, from the sea into rivers. About 20 different species can be distinguished. The best-known are the Sterlet (*A. ruthenus*) from Russian rivers, celebrated for the excellence of its flesh, but rarely exceeding a length of three feet; the Hausen (*A. huso*), from rivers falling into the Black Sea and the Sea of Azow, sometimes 12 feet long, and yielding an inferior kind of isinglass; the Common Sturgeon of the United States (*A. maculosus*), which sometimes crosses the Atlantic to the coasts of Great Britain; Güldenstädt's Sturgeon (*A. gueldenstaedtii*), common in European and Asiatic rivers, which yields more than one fourth of the caviare and isinglass exported from Russia\*; the Common Sturgeon of Western Europe (*A. sturio*), which is said to attain to a length of 18 feet, and has established itself also on the coasts of

[Cases  
29, 30.]

\* In a small table-case between Cases 30 and 31 samples of the best sort of Russian isinglass are exhibited.

Eastern North America. A fine example from the Doggerbank is placed outside the case. *Scaphirhynchus* is a closely allied genus, of which four species are known—one from the river-system of the Mississippi, and the three others from Central Asia.

The *Polyodontidæ*, or Sword-bill Sturgeons, which have the snout produced into an exceedingly long shovel-like or conical process, contain two species—one from the Mississippi, *Polyodon folium*, growing to a length of about six feet; the other, *Psephurus gladius* (exhibited in a tank opposite wall-case 29), inhabits the large rivers of China, the Yantsekiang and Hoangho. The great depth of the rivers in which these fishes live, as well as the turbid condition of their water, renders the organ of sight almost useless: the eyes of these Sturgeons, therefore, are remarkably small; and to obtain their food they evidently use the rostral process in stirring up the mud at the bottom, thus dislodging and finding the small animals on which they prey.

#### Order VIII. CHONDROPTERYGII.

The skeleton is cartilaginous, with the vertebral column generally heterocercal. The body has median and paired fins, the hinder pair being abdominal. The gills are attached to the skin by the outer margin, with several intervening gill-openings (except in the Chimæras, which have only one gill-opening on each side); a gill-cover is absent, as also the air-bladder. Some are viviparous, but the majority are oviparous. A pair of semiossified appendages of the pubic, called *claspers*, are characteristic of all male individuals. These appendages are sometimes armed with hook-like osseous excrescences. They are irregularly longitudinally convoluted, and when closely adpressed to each other form a canal open at their extremity. The ova are large and few in number, and invested with a tough leathery envelope or shell (fig. 90), presenting great variety of shape.

This Order comprises the Chimæras, Sharks and Rays, and is divided into two Suborders—*Holocephala* and *Plagiostomata*.

##### HOLOCEPHALA, or Chimæras (Case 30).

These are chiefly characterized by having one external gill-opening only, covered by a fold of the skin; also their dentition strongly

resembles that of the Dipnoids. In fact this Suborder connects [Case 30.] the Ganoids with the Plagiostomes. It contains one family only, represented in the living fauna by two genera—*Chimæra* and *Callorhynchus*. Of the former three species are known—*Ch. monstrosa*, from deep water off the coasts of Europe, Japan, and the

Fig. 90.



Egg of a Dog-fish (*Scyllium*). (From Magellan Straits.)

Cape of Good Hope; *Ch. colliei*, off the west coast of North America; and *Ch. affinis*, off the coast of Portugal. *Callorhynchus antarcticus* is common in the southern temperate zone, and differs from the preceding by the curious shape of the snout, which bears a cartilaginous prominence terminating in a cutaneous flap.

#### PLAGIOSTOMATA, or Sharks and Rays.

These have from five to seven gill-openings and the teeth are numerous. They differ greatly among each other with regard to

the general form of their body. In the Sharks, or *Selachoidei*, the body is elongate, more or less cylindrical, gradually passing into the tail; their gill-openings are lateral. In the Rays, or *Batoidei*, the gill-openings are always placed on the abdominal aspect of the fish; the body is depressed, and the trunk, which is surrounded by the immensely developed pectoral fins, forms a broad flat disk, the tail appearing as a thin and slender appendage. However, some of the Rays approach the Sharks in having the caudal portion less abruptly contracted behind the trunk. Fossil Plagiostomes are very numerous in all formations, but in the oldest the only remains they have left consist of teeth and fin-spines. Some of the earliest determinable fish-remains are believed to be, or are, derived from the Plagiostomes. The recent forms, of which nearly 300 species are known to exist, are arranged in the following families:—

A. *Selachoidei*, or Sharks.

1. *Carchariidæ*. 2. *Lamnidæ*. 3. *Rhinodontidæ*. 4. *Notidanidæ*.
5. *Scylliidæ*. 6. *Cestraciontidæ*. 7. *Spinacidæ*. 8. *Rhinidæ*.
9. *Pristiophoridæ*.

B. *Batoidei*, or Rays.

10. *Pristidæ*. 11. *Rhinobatidæ*. 12. *Torpedinidæ*. 13. *Raiidæ*.
14. *Trygonidæ*. 15. *Myliobatidæ*.

A. SELACHOIDEI: Sharks.

Sharks are most numerous in the tropics, and become scarcer beyond; they are exclusively carnivorous, and those armed with powerful cutting-teeth are the most formidable tyrants of the ocean. Many of the smaller kinds are eaten. Sharks' fins form in India and China an important article of trade (specimens of this article are exhibited in Case 32). Sharks have no scales, like other fishes; their skin is covered with calcified papillæ, and if these papillæ are small, pointed, and close-set, the skin is called "shagreen."

[Cases 31-33.] *Carchariidæ* (Cases 31-34).—To this family belong the true Sharks (*Carcharias*), common in the tropical, but less so in the temperate seas. Numerous species are distinguished, of which one of the most common is the Blue Shark (*C. glaucus*). Indi-

viduals of from twelve to fifteen feet are of very common occurrence, but some of the species attain a much larger size and a length of 25 or more feet. Such large specimens are very dangerous to man.

The species of *Galeocерdo* (Case 33: two large specimens of *G. arcticus*, fig. 91, in the middle of the Gallery) also attain to a very

Fig. 91.



*Galeocерdo arcticus*. (From the Indo-Pacific and Atlantic Oceans.)

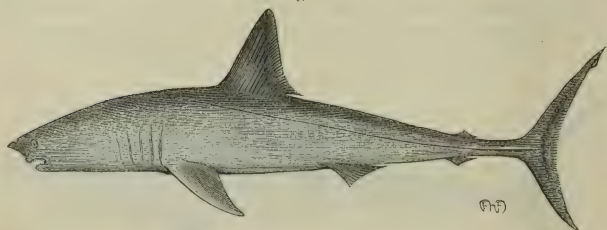
The figure of the tooth is of the natural size, and taken from a specimen 11 feet long.

large size, and belong to the most dreaded of their kind. On the other hand, the Tope (*Galeus*) is a diminutive form, spread over nearly all the temperate and tropical seas, and common in California and Tasmania; one species (*G. canis*) occurs in British seas. The Hammerheads (*Zygæna*) (Case 34) have the same powerful den- [Case 34.] tition as *Carcharias*, and although they do not attain to the same large size, they belong to the most formidable fishes of the ocean. The peculiar form of their head is quite unique among fishes, the anterior part being produced into a lobe on each side, the extremity of which is occupied by the eye. The relation of this singular structure to the mode of life of the Hammerheads is not known. By far the most common is *Z. malleus*, which occurs in nearly all tropical and subtropical seas. The "Hounds" (*Mustelus*) are small Sharks, abundant on the coasts of all the temperate and tropical seas; two of the five species known occur on the coasts of Europe, viz. *M. lævis* and *M. vulgaris*.



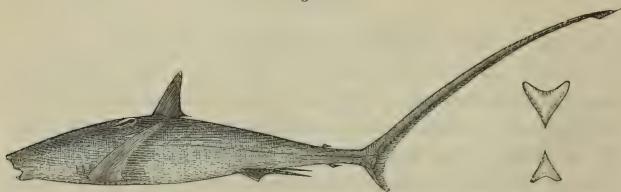
[Case 35.] *Lamnidae* (Case 35).—All the fishes of this family attain to a very large size and are pelagic. The Porbeagle (*Oxyrhina cornubica*, fig. 92) occurs in the North Atlantic, frequently straying to the

Fig. 92.

Porbeagle (*Oxyrhina cornubica*).

British coasts. It attains to a length of ten feet, and feeds chiefly on fishes; its lanceolate teeth are not adapted for cutting, but rather for seizing and holding its prey, which it appears to swallow whole. *Carcharodon rondeletii*, of which enormous jaws are exhibited, is the most formidable of all Sharks. It is strictly pelagic, and appears to occur in all tropical and subtropical seas. It is said to attain to a length of 40 feet. The Fox-Shark or Thresher

Fig. 93.

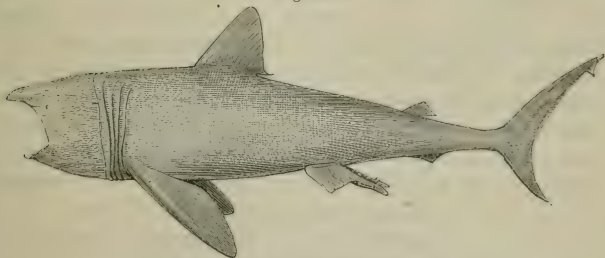
Thresher Shark (*Alopias vulpes*).

The figures of the teeth are those of the upper and lower jaws, of the natural size, and taken from a specimen 14 feet long.

(*Alopias vulpes*, fig. 93) (exhibited in Case 35, and also in the corridor leading into this Gallery) is the most common of the larger kinds of Sharks which occur on the British coasts; and seems to be equally common in other parts of the Atlantic and Mediterranean, as well as on the coasts of California and New Zealand. It attains to a length of 15 feet, of which the tail takes more than one half, and is

quite harmless to man. It follows the shoals of Herrings, Pilchards, and Sprats in their migrations, destroying incredible numbers; when feeding it uses its long tail in splashing the surface of the water, whilst it swims in gradually decreasing circles round a shoal of fishes, which, thus kept crowded together, fall an easy prey to their enemy. The Basking-Shark (*Selache maxima*, fig. 94),

Fig. 94.

Basking-Shark (*Selache maxima*).

of which a male specimen 28 feet long, obtained near Shanklin, Isle of Wight, is exhibited in the middle of the Gallery, is the largest Shark of the North Atlantic, growing to a length of more than 30 feet. It is quite harmless if not attacked, its food consisting of small fishes and other small marine animals which swim in shoals. On the west coast of Ireland it is chased for the sake of the oil which is extracted from its liver, one fish (it is said) yielding from a ton to a ton and a half. Its capture is attended with some danger, as one blow from its enormously strong tail is sufficient to stave in the sides of a large boat.

The *Rhinodontidæ* comprise one species only, *Rhinodon typicus*, a gigantic Shark which, though in most respects agreeing with the *Scylliidæ*, resembles the Basking-Sharks in the structure of its gills. It is found in various parts of the Indian Ocean. The specimen (18 feet long) exhibited in the middle of the Gallery was procured in Ceylon, and is quite young,—this species being known to exceed a length of fifty feet; its teeth are very small, as in the Basking-Shark, and, like that species, it is quite harmless.

The *Notidanidæ* are characterized by having only one dorsal fin, without spine, opposite to the anal, and by lacking a nictitating membrane or eyelid; they contain two genera—*Notidanus*,

[Cases  
36-39.]

distributed over nearly all the tropical and subtropical seas ; and *Chlamydoselache*, from Japan, Madeira, and Finmark.

The *Scylliidae*, or Dog-fishes, are mostly of small size. The teeth are small and generally arranged in several series ; the fins are not armed with spines, a nictitating membrane is absent, and the spiracle is always distinct. Two species of *Scyllium* are found on the British coast—the “Larger” and “Lesser Spotted Dog-fish,” *S. caniculum* and *S. catulus*. They are coast-fishes, living on the bottom, and feeding on crustaceans, dead fishes, &c. The Zebra- or Tiger-Shark, *Stegostoma tigrinum*, one of the commonest and handsomest Sharks of the Indian Ocean, reaches a size of 10 to 15 feet. *Crossorhinus* (Case 39), a genus of ground Sharks from the Indo-Pacific Ocean ; they are sluggish and lie concealed on the bottom watching for their prey. In accordance with this habit their colour closely assimilates that of a rock or stone covered with short vegetable and coralline growth, a resemblance which is increased by the frond-like tentacles on the side of the head.

[Case 40.] The *Cestraciontidae* (Case 40) have, like the preceding, several series of teeth simultaneously in function ; each of the dorsal fins is armed with a spine. This family is one of particular interest, because representatives of it occur in numerous modifications in Primary and Secondary strata. Their dentition (of which preparations are shown in Table-case C) is adapted for the prehension as well as mastication of crustaceous and hard-shelled animals. A few recent species are known, from various parts of the Pacific Ocean.

The *Spinacidae*, or Spiny Dog-fishes (Cases 39, 40), so called on account of the spine with which their dorsal fins are usually armed, are a family containing numerous genera, the majority of the species being of small size. *Acanthias* is the best known, the two species, *A. vulgaris* and *A. blainvillii*, occurring on the British coast. The species of *Centrophorus* live at a considerable depth, perhaps at a greater depth than any of the other known Sharks. The Portuguese fishermen fish for them in 400 or 500 fathoms with a line of some 600 fathoms in length. The Greenland Shark (*Læmargus borealis*) is an inhabitant of the Arctic regions, rarely straying to the latitudes of Great Britain. It grows to a length of about 15 feet, and is extremely voracious. The “Spinous Shark” (*Echinorhinus spinosus*) is a ground Shark, probably living at some depth, and but accidentally coming to the surface. More frequently met with in the Medi-

terranean, it has been found occasionally on the south coast of England.

The family of *Rhinidæ* contains only one species, the "Angel-fish" [Case 41.] or "Monk-fish" (*Rhina squatina*) (Case 41), which approaches the Rays as regards form and habits. Within the temperate and tropical zones it is almost cosmopolitan; it does not exceed a length of five feet; it is viviparous, producing about twenty young at a birth.

The *Pristiophoridæ* (Case 41) resemble so much the common Saw-fishes as to be easily confounded with them, but their gill-openings are lateral, and not inferior. They are also much smaller in size, and a pair of long tentacles are inserted at the lower side of the saw. The four species known occur in the Australian and Japanese seas.

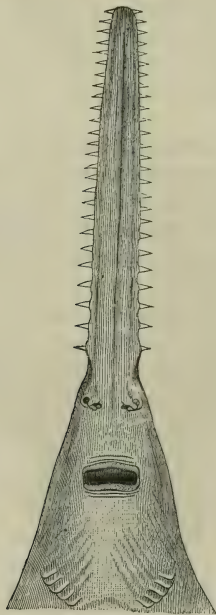
#### B. BATOIDEI: Rays.

The true Rays lead a sedentary life, moving slowly on the bottom, rarely ascending to the surface. They progress solely by means of the pectoral fins, the broad and thin margins of which are set in an undulating motion, identical with that of the dorsal and anal fins of the *Pleuronectidæ*, or Flat-fishes. They are exclusively carnivorous, like the Sharks, but unable to pursue and catch rapidly-moving animals.

The Saw-fishes, *Pristidæ* (Case 41), agree with the Rays in the position of their branchial clefts. They are abundant in tropical, less so in subtropical seas. They attain to a considerable size, specimens with a saw 6 feet long and 1 foot broad at the base not being of uncommon occurrence. The saw renders them most dangerous to almost all the other large inhabitants of the ocean. Its skeleton consists of three, sometimes five, rarely four, hollow cylindrical tubes, placed side by side, tapering towards the end, and incrustated with an osseous deposit, as shown in a preparation in Table-case C. The teeth of the saw are implanted in deep sockets of the hardened integument, and are, as regards their origin, from dermal papillæ, and their mode of attachment a unique structure among Fishes. The teeth proper, with which the jaws are armed, are much too small for inflicting wounds or seizing other animals. Saw-fishes use the saw in tearing pieces of flesh off an animal's body or ripping open its abdomen; the detached fragments or protruding soft parts

are then seized by them and swallowed. They feed also largely on cuttle-fishes.

Fig. 95.



Lower view of head of Saw-fish.

[Case 42.] The *Rhinobatidæ* (Case 42) contain the genera *Rhynchobatus*, *Rhinobatus*, and *Trygonorhina*. A fine series of *Rhynchobatus ancylostomus*, with preparations of its curious dentition, is exhibited in a separate case in the middle of the Gallery. They feed on hard-shelled animals, and attain scarcely a length of 8 feet. They are confined to the coasts of tropical and subtropical seas.

The *Torpedinidæ*, or Electric Rays (Case 42).—The electric organs with which these fishes are armed are large, flat bodies lying one on each side of the head; they consist of an assemblage of vertical hexagonal prisms, whose ends are in contact with the integuments above and below. The fish gives the electric



shock voluntarily, when it is excited to do so in self-defence or intends to stun or kill its prey; but to receive the shock the object must complete the galvanic circuit by communicating with the fish at two distinct points, either directly or through the medium of some conducting body. It is said that a painful [Case 42.]

Fig. 96.



Electric Ray (*Torpedo marmorata*). (From the Mediterranean.)

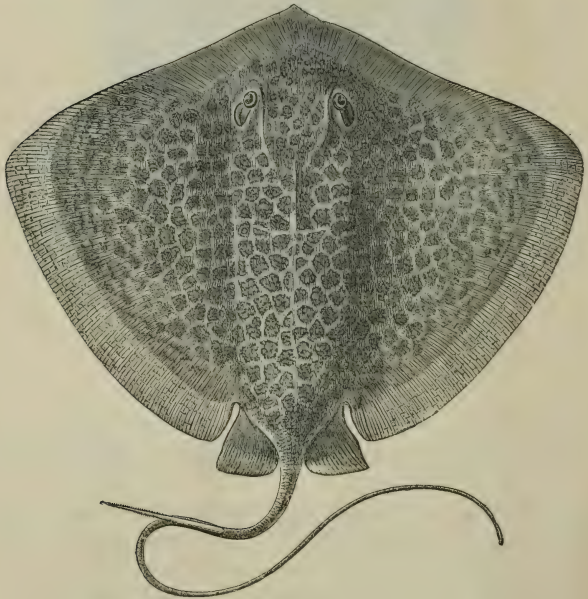
sensation may be produced by a discharge conveyed through the medium of a stream of water. The electric currents created in these fishes exercise all the other known powers of electricity: they render the needle magnetic, decompose chemical compounds, and emit the spark. The dorsal surface of the electric organ is positive, the ventral negative. This family contains several genera, of which *Torpedo* is the best known. Of the latter six species are known, distributed over the Atlantic and Indian

Oceans ; three of them are rather common in the Mediterranean, and one (*T. nobiliana*) reaches the south coast of England. They attain to a width of from two to three feet, and specimens of that size can disable by a single discharge a full-grown man, and therefore may prove dangerous to persons bathing.

[Case 43.]

The *Raiidæ*, or True Rays (Case 43), have a wide geographical range; they are chiefly inhabitants of temperate seas, and much more numerous in those of the northern than of the southern hemisphere. More than 30 species of the genus *Raia* are known, of which the following are found on the British coasts :—The

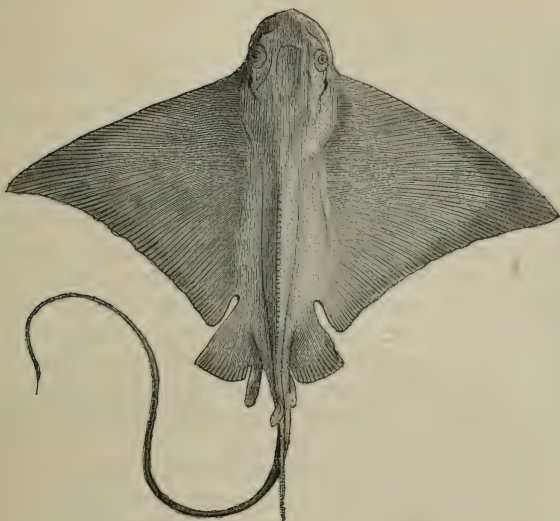
Fig. 97.



Sting-Ray (*Trygon uarnak*). (From Madras.)

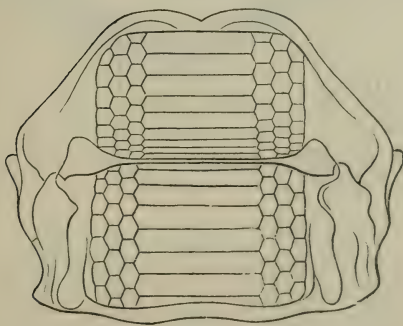
Thornback (*R. clavata*), the Homelyn Ray (*R. maculata*), the Painted Ray (*R. albopicta*), the Starry Ray (*R. radiata*), the

Fig. 98.



Eagle-Ray (*Myliobatis aquila*). (From Madeira.)

Fig. 99.



Jaws of the Eagle-Ray (*Myliobatis*).

Sandy Ray (*R. circularis*), the Cuckoo Ray (*R. miraletus*), the Common Skate (*R. batis*), the Flapper Skate (*R. macrorhynchus*), the Burton Skate (*R. marginata*), and the Shagreen Skates (*R. fullonica* and *R. vomer*). Some of these species, especially the Skates, attain a considerable size, the disk measuring six and even seven feet across. All are eatable, and some of them regularly brought to market. Teeth are exhibited in Table-case C.

[Case 44.] The *Trygonidæ*, or Sting-Rays (Cases 43, 44), are as numerous as the Rays proper, but they inhabit tropical rather than temperate seas. The species armed with a spine use it as a weapon of defence, and the wounds inflicted by it are, to man, extremely painful, and have frequently occasioned the loss of a limb. Some forms, however (*Urogymnus*, Case 43), are devoid of that caudal weapon. The genus *Trygon* is numerous in species, one of which (*T. pastinaca*) occurs on the south coast of England. Large specimens of *T. sephen* and *T. uarnak* (fig. 97), and of a New-Zealand species (*T. brevicauda*), are exhibited on stands opposite Case 42 and in the corridor leading into this Gallery.

The *Myliobatidæ* (Case 44), also called Devil-fishes, Sea-devils, or Eagle-Rays, are generally of large size, inhabiting temperate and tropical seas. The tail is very long and slender. Some genera (*Cephaloptera*, *Dicerobatis*) possess a pair of singular cephalic processes, which generally project in a direction parallel to the longitudinal axis of the body, but are said to be flexible in the living fish, and used for scooping food from the bottom of the water and conveying it to the mouth. Some of them, if not all, attain an enormous size; specimens weighing 1250 pounds, or measuring 20 feet in width, are on record. In the *Myliobatina* the dentition consists of perfectly flat molars, forming a kind of mosaic pavement in both the upper and lower jaws—a most perfect mechanical arrangement for crushing alimentary substances. Examples of the dentition are exhibited in Table-case C.

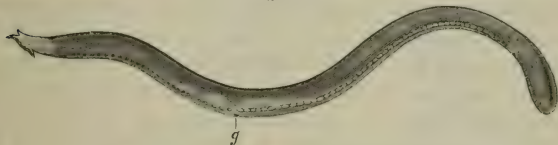
### CYCLOSTOMATA. (Case 44.)

Their skeleton is cartilaginous and notochordal, without ribs and without real jaws; the skull is not separated from the vertebral column. Limbs are absent, and the body is eel-like. The gills are in the form of fixed sacs, without branchial arches, numbering

six or seven on each side. There is a single nasal aperture. The [Case 44.] mouth is anterior and suctorial, surrounded by a circular or sub-circular lip.

This Subclass comprises the Lampreys (*Petromyzon*) and Hag-fish (*Myxine*). The former are found in the rivers and on the coasts of the temperate regions of the northern and southern hemispheres. Their habits are but incompletely known, but so much is certain that at least some of them ascend rivers periodically for the purpose of spawning, and that the young pass several years in rivers whilst they undergo a metamorphosis. In the larvæ the mouth is toothless, and surrounded by an imperfect lip. The Lampreys feed on other fishes, to which they suck themselves fast, scraping off the flesh with their teeth. Whilst thus engaged they are carried about by their victim. The British species are the Sea-Lamprey (*Petromyzon marinus*), exceeding a length of three feet, and not uncommon on the European and North-American coasts; the River-Lamprey or Lampern (*P. fluviatilis*), ascending in large numbers the rivers of Europe, North America, and Japan, and scarcely attaining a length of two feet; the "Pride" or "Sand-piper" or "Small Lampern" (*P. branchialis*), scarcely 12 inches long, the larva of which has long been known under the name of *Annucætes*. The Hag-fishes, or *Myxine* (fig. 100), are marine fishes

Fig. 100.

Hag (*Myxine*). (From the German Ocean.)

g. Gill-opening.

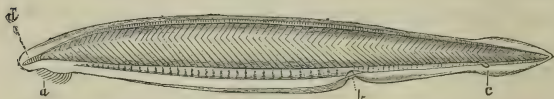
most plentiful in the higher latitudes of the temperate zones of the northern and southern hemispheres; some descend to a depth of 345 fathoms. They are frequently found buried in the abdominal cavity of other fishes, especially Gadoids, into which they penetrate to feed on their flesh. When caught, they secrete a thick glutinous slime in incredible quantities, and are therefore considered by fishermen a great nuisance, seriously interfering with the fishing in localities where they abound.



## LEPTOCARDII.

The Lancelet (*Branchiostoma* or *Amphioxus*) has been long considered to be the lowest in the scale of fishes, but it lacks so many characteristics, not only of this class, but of the Vertebrata generally, that it is better referred to a separate class, the chief characters of which are as follows:—Skeleton membrano-cartilaginous and notochordal, ribless. No brain. Pulsating sinuses in place of a heart. Blood colourless. Respiratory cavity confluent with the abdominal cavity; branchial clefts in great number, the water being expelled by an opening in front of the vent. Jaws none. Six species of Lancelet (*Branchiostoma*, fig. 101) are known, and

Fig. 101.

Lancelet (*Branchiostoma*).

*a*, mouth; *b*, abdominal pore; *c*, vent; *d*, anterior end of notochord.

found at almost every suitable locality within the temperate and tropical zones. Their small size (rarely exceeding three inches), transparency, and the rapidity with which they are able to bury themselves into the sand are the causes why they so readily escape observation, even at localities where they are known to be common. Shallow, sandy parts of the coast, at some distance from the influx of fresh water, seem to be the places on which the Lancelet may be looked for; in a larval condition it is frequently obtained in the tow-net at any distance from land.

# INDEX.

- Abramis*, 85.  
*Acanthias*, 106.  
*Acanthoclinidae*, 59.  
*Acantholabrus*, 77.  
*Acanthopterygii*, 57, 58.  
*Acanthurus*, 73.  
*Acipenser*, 98.  
*Acipenseridae*, 99.  
*Acrochordinae*, 19, 22.  
*Aeronuridae*, 59, 73.  
*Agamidae*, 7, 12.  
*Aglossa*, 36.  
*Agua Toad*, 39.  
*Albacore*, 65.  
*Albula*, 89.  
*Alburnus*, 85.  
*Alepocephalidae*, 82.  
*Alligator*, 5.  
 ——— *Terrapen*, 28.  
*Alopiidae*, 104.  
*Alytes*, 41.  
*Amblycephalidae*, 19.  
*Amblyrhynchus*, 11.  
*Amia*, 96.  
*Amioidei*, 96.  
*Ammocetes*, 113.  
*Anmodytes*, 80.  
*Amphibolurus*, 14.  
*Amphignathodontidae*, 36, 41.  
*Amphioxus*, 114.  
*Amphisbænidae*, 7, 9.  
*Amphiumidae*, 42, 43.  
*Anabas*, 74.  
*Anacanthini*, 58, 78.  
*Anaconda*, 20.  
*Anarrhichas*, 72.  
*Anelytropidae*, 7.  
*Angel-fish*, 107.  
*Angler*, 71.  
*Anguidae*, 7, 10.  
*Anguilla*, 90.  
*Anniellidae*, 7.  
*Anolis*, 11.  
*Aphredoderidae*, 59.  
*Apoda*, 33, 46.  
*Arapaima*, 88.  
*Archæopteryx*, 1.  
*Arcifera*, 36.  
*Arius*, 82.  
*Aspredo*, 83.  
*Atherines*, 59.  
*Atherinidae*, 59.  
*Axolotl*, 42.  
*Bagrus*, 82.  
*Balistes*, 92.  
*Band-fishes*, 59.  
*Barbel*, 84.  
*Barbus*, 84.  
*Barracuda*, 59, 64.  
*Barramunda*, 99.  
*Basking-Shark*, 105.  
*Bass*, 59.  
*Batagur*, 28.  
*Bathyrhynchidae*, 82.  
*Batoidei*, 102, 107.  
*Batrachians*, 31.  
*Batrachidae*, 59.  
*Bayad*, 82.  
*Belone*, 87.  
*Berycidae*, 59.  
*Bib*, 79.  
*Bitis*, 24.  
*Black Bass*, 59.  
*Bleak*, 85.  
*Blennies*, 59.  
*Blenniidae*, 59, 72.  
*Blind Snakes*, 19, 20.  
*Blindworm*, 10.  
*Boa*, 20.  
*Boidae*, 19.  
*Boinae*, 19, 20.  
*Bolty*, 78.  
*Bombinator*, 41.  
*Box-Tortoise*, 28.  
*Branchiostoma*, 58, 114.  
*Bream*, 85.  
*Brill*, 81.  
*Brook-Trout*, 85.  
*Bufo*, 36, 38.  
*Bull-Frog*, 37.  
*Bullheads*, 59, 63.  
*Bulti*, 78.  
*Burbot*, 79.  
*Burnett Salmon*, 99.  
*Burrowing Snakes*, 19, 20.  
*Burton Skate*, 112.  
*Caiman*, 5.  
*Californian Toad*, 11, 12.  
*Callichthys*, 83.  
*Callionymus*, 70.  
*Callorhynchus*, 101.  
*Cantharus*, 60.  
*Caouana*, 27.  
*Carangidae*, 59, 67.  
*Caranx*, 67.  
*Carcharias*, 102.  
*Carchariidae*, 102.  
*Carcharodon*, 104.  
*Caretta*, 27.  
*Caribe*, 84.  
*Carp*, 84.  
*Cat-fish*, 82.  
*Catla*, 84.  
*Caudata*, 33, 42.  
*Centriscidae*, 59.  
*Centrolabrus*, 77.  
*Centrophorus*, 106.  
*Cephaloptera*, 112.  
*Cepolidae*, 59.  
*Ceratobatrachidae*, 36, 41.  
*Ceratodus*, 98, 99.  
*Ceratophrys*, 38.  
*Cestraciontidae*, 102, 106.  
*Chad*, 60.  
*Chætodon*, 62.  
*Chamæleons*, 15.

- Char, 85.  
 Characinidæ, 82, 84.  
*Chaunax*, 72.  
*Chelmo*, 62.  
*Chelone*, 27.  
*Chelonia*, 24.  
 Cheloniidæ, 26, 27.  
 Chelydidæ, 26.  
*Chelydra*, 28.  
*Chelys*, 28.  
*Chimæra*, 101.  
 Chirocentridæ, 82.  
*Chlamydosaurus*, 12, 14.  
*Chlamydoselache*, 106.  
 Chondropterygii, 58, 100.  
 Chondrostei, 96, 99.  
 Chromides, 76, 78.  
*Chrysophrys*, 60.  
 Chub, 85.  
 Cirrhitidæ, 59.  
*Cistudo*, 28.  
 Climbing-Perch, 74.  
*Clupea*, 89.  
 Clupeidæ, 82, 88.  
 Coal-fish, 79.  
*Cobitis*, 85.  
 Cobra, 19, 22.  
 Cod-fish, 78, 79.  
*Oæcilia*, 46.  
 Coffer-fish, 93.  
 Colubridæ, 19, 20.  
 Colubrinæ, 19.  
 Comephoridæ, 59.  
 Common Snake, 21.  
 Conger, 90.  
 Coral Fishes, 59, 61.  
 — Snakes, 19, 22.  
*Coregonus*, 86.  
*Coris*, 77.  
*Coronella*, 21.  
*Coryphæna*, 66.  
 Cottidæ, 59, 62.  
*Cottus*, 63.  
 Craig-fluke, 81.  
*Crenilabrus*, 77.  
 Crocodilia, 3.  
*Crocodylus*, 4.  
*Crossorhinus*, 106.  
 Crotalinæ, 19, 23.  
*Crotalus*, 24.  
 Crucian Carp, 84.  
*Ctenolabrus*, 77.  
*Cyclopterus*, 70.  
 Cyclostomata, 58, 112.  
 Cyprinidæ, 82, 84.  
 Cyprinodontidæ, 82.  
*Cyprinus*, 84.  
 Cystignathidæ, 36, 38.
- Dab, 81.  
 Dace, 85.  
 Dactylethridæ, 36, 42.  
 Dactylopterus, 63.  
 Dasypeltinæ, 19.  
 Dawson Salmon, 99.  
 Deep-sea Fishes, 48.  
 Dendrobatidæ, 36, 38.  
 Dendrophryniscidæ, 36.  
 Devil-fish, 112.  
 Dibamidæ, 7.  
*Dicerobatis*, 112.  
*Diodon*, 93.  
 Dipnoi, 96, 97.  
 Dipsadomorphinæ, 19.  
 Discoboli, 59, 69.  
 Discoglossidæ, 36, 41.  
 Dog-fish, 106.  
 —, Spiny, 106.  
 Dolphin, 66.  
*Dracæna*, 9.  
*Draco*, 12.  
 Dragon, 12.  
 Dragonet, 70.  
 Drum, 64.  
 Dyscophidæ, 36.
- Eagle-Ray, 111, 112.  
 Earth-Snakes, 19.  
 Ecaudata, 33.  
*Echeneis*, 65.  
*Echinorhinus*, 106.  
 Eel, 89, 90.  
 Eel-pout, 79.  
*Egernia*, 10.  
 Elacate, 66.  
 Elachistodontiræ, 19.  
 Elapinæ, 19, 22.  
*Elaps*, 22.  
 Electric Cat-fish, 83.  
 — Eel, 89.  
 — Rays, 108.  
*Elops*, 89.  
 Embiotocidæ, 76, 78.  
 Emydidæ, 26, 28.  
*Emys*, 28.  
 Engystomatidæ, 36.  
*Epinephelus*, 60.  
 Eryces, 20.  
 Esocidæ, 82, 87.  
 Eublepharidæ, 7.  
*Erocætus*, 63, 87.
- File-fish, 92.  
 Firmisternia, 36, 41.  
 Fishes, 47.  
 Fishing-frog, 71.  
 Fistulariidæ, 59, 76.  
 Flat-fishes, 78, 81.
- Flounder, 81.  
 Flute-mouths, 59, 76.  
 Flying-fish, 63, 87.  
 Flying-Herrings, 63.  
 Fox-Shark, 104.  
 Freshwater Snakes, 22.  
 — Tortoises, 26, 28.  
 — Turtles, 26, 27.  
 Frilled Lizard, 12.  
 Frog, Common, 37.  
 —, Common Indian, 37.  
 —, Edible, 37.  
 — fishes, 59.  
 —, Flying, 37.  
 —, Horned, 38.  
 —, Marsupial, 39.  
 —, Quadrumanous, 39.
- Gadidæ, 79.  
 Gadoidei, 78.  
*Gadus*, 79.  
 Galaxiidæ, 86.  
*Galeocерdo*, 103.  
*Galeus*, 103.  
 Ganoidei, 58, 95.  
 Gar-Pike, 86, 96.  
 Gastrosteidæ, 59, 75.  
*Gavialis*, 5.  
*Gecko*, 8.  
 Geckonidæ, 7, 8.  
*Gecoemyda*, 28.  
 Gerrhosauridæ, 7.  
 Gharial, 5.  
 Gigantic Tortoise, 29.  
 Gilt-head, 60.  
 Glass-Snake, 10.  
 Glaucioniidæ, 19, 20.  
 Globe-fish, 93.  
 Gobies, 59.  
 Gobiesocidæ, 59.  
 Gobiidæ, 59, 69.  
*Gobius*, 70.  
 Goldfish, 84.  
 Gonorhynchidæ, 82.  
 Gourami, 74.  
 Grayling, 86.  
 Greenland Shark, 106.  
 Green Lizard, 10.  
 — Turtle, 27.  
 Grey Mullet, 59, 75.  
 Gurnards, 59, 62, 63.  
*Gymnarchus*, 86.  
 Gymnodontes, 92, 94.  
 Gymnotidæ, 82, 88.
- Haddock, 79.  
 Hag-fish, 113.  
 Hair-tails, 59.  
 Hake, 79.

- Ikalosauridæ*, 82.  
*Hamadryad*, 22.  
*Hammerheads*, 103.  
*Haplochitonidæ*, 82.  
*Hatteria*, 5.  
*Hausen*, 99.  
*Hawk's-bill Turtle*, 27.  
*Heloderma*, 9.  
*Helodermatidæ*, 7.  
*Hemiphractidæ*, 36, 41.  
*Heniochus*, 62.  
*Herring*, 89.  
*Hesperornis*, 1.  
*Heteropygii*, 82.  
*Heterotis*, 88.  
*Hippocampus*, 91, 92.  
*Hippoglossus*, 81.  
*Histiophorus*, 68.  
*Holacanthus*, 62.  
*Holibut*, 81.  
*Holocephala*, 100.  
*Homalopsinæ*, 19, 22.  
*Homelyn Ray*, 110.  
*Hoplognathidæ*, 59.  
*Horned Toad*, 12.  
*Horse-Mackerels*, 59, 67.  
*Hound*, 103.  
*Hydrocyon*, 84.  
*Hydrophiinæ*, 19, 22.  
*Hydrophis*, 23.  
*Hylidæ*, 36, 39.  
*Hyodontidæ*, 82.  
  
*Ichthyophis*, 46.  
*Iguanas*, 9, 11.  
*Iguanidæ*, 7, 11.  
*Ilysiidæ*, 19.  
*Innocuous Snakes*, 19.  
  
*John Dory*, 65.  
  
*King-fish*, 66.  
  
*Labrax*, 59.  
*Labridæ*, 76.  
*Labrus*, 77.  
*Labyrinthici*, 59, 74.  
*Labyrinthodonta*, 33.  
*Lacertidæ*, 7, 10.  
*Lacertilia*, 6.  
*Lamargus*, 106.  
*Lake-Wenern Trout*, 85.  
*Lamnidæ*, 102, 104.  
*Lampern*, 113.  
*Lampreys*, 58, 113.  
*Lampriæ*, 66.  
*Lancelet*, 114.  
  
*Land-Tortoises*, 26, 28.  
*Launce*, 80.  
*Leather-Turtles*, 26.  
*Lepidosiren*, 98.  
*Lepidosteoidæ*, 96, 97.  
*Lepidosteus*, 97.  
*Leptocardii*, 58, 114.  
*Leuciscus*, 84.  
*Limbless Batrachians*, 46.  
*Ling*, 79.  
*Lizard*, 6, 10.  
*Loach*, 85.  
*Loggerhead Turtle*, 27.  
*Lophius*, 71.  
*Lophobranchii*, 58, 91.  
*Lophotidæ*, 59.  
*Lota*, 79.  
*Luciocephalidæ*, 59.  
*Lucioperca*, 59.  
*Lumpsuckers*, 59, 70.  
*Lutremys*, 28.  
*Lycodidæ*, 79.  
  
*Mackerel*, 59, 65.  
*Macruridæ*, 79.  
*Mahaseer*, 84.  
*Malacanthidæ*, 59.  
*Malapterurus*, 83.  
*Maithe*, 72.  
*Marine Turtles*, 27.  
*Mastacembelidæ*, 59.  
*Mata-Mata*, 28.  
*Meagres*, 59, 64.  
*Megalobatrachus*, 44.  
*Megalops*, 89.  
*Midwife Toad*, 41.  
*Millers'-thumbs*, 63.  
*Minnow*, 85.  
*Molge*, 43.  
*Moloch*, 14.  
*Molva*, 79.  
*Monacanthus*, 92.  
*Monitor*, 9.  
*Monk-fish*, 107.  
*Morelia*, 21.  
*Mormyridæ*, 82, 87.  
*Mossbanker*, 89.  
*Mud-fish*, 96.  
*Mugilidæ*, 59, 75.  
*Mullidæ*, 59, 60.  
*Murænidæ*, 82, 90.  
*Muskellonge*, 87.  
*Mustelus*, 103.  
*Myletes*, 84.  
*Myliobatidæ*, 102, 112.  
*Myxine*, 113.  
  
*Naja*, 22.  
*Nandidæ*, 59.  
  
*Naseus*, 74.  
*Natterjack*, 38.  
*Naucrates*, 67.  
*Nemachilus*, 85.  
*Newt*, 43.  
*Norway Pout*, 79.  
*Notacanthidæ*, 82.  
*Notidanidæ*, 102, 105.  
*Notopteridæ*, 82.  
*Nototrema*, 39.  
  
*Onus*, 79.  
*Opah*, 66.  
*Ophidia*, 16.  
*Ophidiidæ*, 79, 80.  
*Ophiocephalidæ*, 59.  
*Ophiophagus*, 22.  
*Orthogoriscus*, 94, 95.  
*Osmerus*, 86.  
*Osphromenus*, 74.  
*Osteoglossidæ*, 82, 88.  
*Ostracion*, 92, 93.  
*Oxudercidæ*, 59.  
*Oxyrhina*, 104.  
  
*Pagellus*, 60.  
*Pagrus*, 61.  
*Palæichthyes*, 58, 96.  
*Parrot-Wrasses*, 77.  
*Pediculari*, 59, 70.  
*Pelagic Fishes*, 48.  
*Pelamys*, 23.  
*Pelobatidæ*, 36.  
*Perch*, 59.  
*Percidæ*, 59.  
*Percopsidæ*, 82.  
*Petromyzon*, 113.  
*Phanerolossa*, 36.  
*Pharyngognathi*, 76.  
*Phrynosoma*, 11.  
*Phyllomedusa*, 39.  
*Physostomi*, 58, 82.  
*Pike*, 86.  
*Pike-Perch*, 59.  
*Pilehard*, 88.  
*Pilot-fish*, 67.  
*Pimelodus*, 83.  
*Pipa*, 42.  
*Pipe-fish*, 92.  
*Pipidæ*, 36, 42.  
*Pit-Vipers*, 19, 24.  
*Plagiostomata*, 100, 101.  
*Plaice*, 81.  
*Platax*, 68.  
*Plectognathi*, 58, 92.  
*Pleuronectes*, 81.  
*Pleuronectidæ*, 81.  
*Podocnemys*, 28.  
*Pogonias*, 64.

- Pollack, 79.  
 Polycentridæ, 59.  
 Polynemidæ, 59, 64.  
*Polyodon*, 100.  
 Polyodontidæ, 99, 100.  
 Polypteroidei, 96.  
*Polypterus*, 96.  
 Pomacentridæ, 76.  
 Porbeagle, 104.  
 Pout, 79.  
 Power-Cod, 79.  
 Pride, 113.  
 Pristidæ, 102, 107.  
 Pristiophoridae, 102, 107.  
 Proteidæ, 42, 45.  
*Proteus*, 45.  
*Protopterus*, 98.  
*Psephurus*, 100.  
*Pseudis*, 38.  
*Pseudopus*, 10.  
*Pseudoscarus*, 77.  
 Psychrolutidæ, 59.  
*Pterois*, 22.  
 Puff-Adder, 24.  
 Pygopodidæ, 7.  
 Pythoninæ, 19, 20.  
 Pyxidea, 28.  
  
*Raia*, 110.  
 Raiidæ, 102, 110.  
 Ranidæ, 36, 37.  
 Rat-Snakes, 20.  
 Rattlesnakes, 19, 23, 24.  
 Rays, 101, 110.  
 Red Mullet, 59, 60.  
 Rhinidæ, 102, 107.  
 Rhinobatidæ, 102, 108.  
*Rhinobatus*, 108.  
 Rhinodontidæ, 102, 105.  
*Rhombus*, 81.  
*Rhynchobatus*, 108.  
 Rhynchocephalia, 5.  
 Ribbon-fishes, 59, 73.  
 Ringed Snake, 21.  
 Roach, 85.  
 Rockling, 79.  
 Rock-Snakes, 20.  
 Rudd, 85.  
  
 Salamander, 42, 43.  
 —, Gigantic, 44.  
 Salamandridæ, 42.  
 Salmon, 85.  
 Salmonidæ, 82, 85.  
 Sand-Eel, 80.  
 Sand-Lizard, 10.  
 Sandpiper, 113.  
  
 Sand-Snakes, 19.  
 Sardine, 89.  
*Sargus*, 60.  
 Saw fish, 107.  
*Scaphirhynchus*, 100.  
*Scarus*, 77.  
*Sciæna*, 64.  
 Sciænidæ, 59, 64.  
 Scincidæ, 7, 10.  
 Sclerodermi, 92.  
 Seombresocidæ, 82, 87.  
 Seombridæ, 59.  
 Scorpænidæ, 59, 62.  
 Scopelidæ, 82.  
 Scylliidæ, 102, 106.  
 Scyllium, 106.  
 Sea-bat, 68.  
 Sea-Breams, 59, 60.  
 Sea-cat, 72.  
 Sea-devil, 70, 112.  
 Sea-hedgehog, 94.  
 Sea-horse, 92.  
 Sea-Perch, 59.  
 Sea-Snakes, 19, 22.  
 Sea-Surgeons, 73.  
 Sea-Trout, 85.  
 Sea-Turtles, 26.  
 Sea-Wolf, 72.  
*Sebastes*, 62.  
*Selache*, 105.  
 Selachoidæ, 102.  
*Seriola*, 67.  
*Serranus*, 59.  
 Shad, 89.  
 Shagreen Skate, 112.  
 Sharks, 100, 102.  
 Shark, Blue, 102.  
 —, Spinous, 106.  
 Sheep's-head, 60.  
 Sheltopusik, 10.  
 Shore-fishes, 48.  
 Siluridæ, 82.  
*Silurus*, 82.  
*Siphonops*, 46.  
 Sirenidæ, 42, 45.  
 Skates, 112.  
 Skink, 10.  
 Slowworm, 10.  
 Smear-Dab, 81.  
 Smelt, 86.  
 Smooth Snake, 21.  
 Snakes, 16.  
 Snapper, 61.  
 Sole, 81.  
*Solea*, 81.  
 Solenostomidæ, 91.  
 Sparidæ, 60.  
 Sphargidæ, 26.  
 Sphyrænidæ, 59, 64.  
  
 Spinacidæ, 102, 106.  
 Spiny-rayed Fishes, 5, 8.  
 Sprat, 89.  
 Squamipinnes, 59, 61.  
*Stegocephala*, 33.  
 Stenopterychidæ, 32.  
 Sterlet, 99.  
 Sticklebacks, 59, 75.  
 Sting-Rays, 112.  
 Stock-fish, 79.  
 Stomiadæ, 82.  
 Sturgeon, 99.  
 —, Sword-bill, 100.  
 Sucking-fish, 65.  
 Sun-fish, 94.  
 Surgeons, 59, 73.  
 Surinam Toad, 42.  
 Sword-fishes, 59, 68.  
 Symbranchidæ, 82.  
*Synanceia*, 62.  
 Syngnathidæ, 91.  
*Syngnathus*, 91, 92.  
  
 Tailed Batrachian, 24.  
 Tailless Batrachians, 33.  
 Tarpon, 89.  
 Teguxin, 9.  
 Teiidæ, 7, 9.  
 Teleostei, 57, 58.  
 Tench, 85.  
 Terrapen, 28.  
 Testudinidæ, 26, 28.  
*Tetrodon*, 94.  
 Teuthididæ, 59.  
 Thornoack, 110.  
 Thresher, 104.  
*Thymallus*, 86.  
*Thynnus*, 65.  
 Tiger-Shark, 106.  
*Tiliqua*, 10.  
*Tinca*, 85.  
 Toad, 38.  
 —, Fire-bellied, 41.  
*Tomistoma*, 5.  
 Tope, 103.  
 Torpedinidæ, 102, 108.  
 Torpedo, 109.  
 Tortoise, 24.  
*Toxotes*, 62.  
 Trachinidæ, 59, 63.  
 Trachydosaurus, 10.  
 Trachypteridæ, 59, 73.  
 Tree-Frog, 38, 39.  
 Tree-Snakes, 21.  
*Triacanthus*, 92.  
 Trichiuridæ, 59.  
 Trichonotidæ, 59.  
*Tripla*, 63.  
*Triodon*, 94.



- |                             |                     |                      |
|-----------------------------|---------------------|----------------------|
| Trionychidæ, 26, 27.        | Uropeltidæ, 19.     | Whiting, 79.         |
| <i>Tropidonotus</i> , 21.   | Uroplatidæ, 7.      | Wrasses, 76.         |
| Trout, 85.                  |                     |                      |
| Trygonidæ, 102, 112.        | Varanidæ, 7, 8.     | Xantusiidæ, 7.       |
| <i>Trygonorkhina</i> , 108. | <i>Varanus</i> , 9. | Xenopeltidæ, 19.     |
| Tuatera, 5.                 | Vendace, 86.        | <i>Xenopus</i> , 42. |
| Tunny, 65.                  | Viperidæ, 19.       | Xenosauridæ, 7.      |
| <i>Tupinambis</i> , 9.      | Viperinæ, 19, 23.   | <i>Xiphias</i> , 68. |
| Turbot, 81.                 | Vipers, 19, 23, 24. | Xiphiidæ, 59, 68.    |
| Turtle, 24.                 |                     |                      |
| Typhlopidae, 19, 20.        | Water-Lizard, 9.    | Yellow-tail, 67.     |
|                             | Weevers, 59, 63.    |                      |
| Umbridæ, 82.                | Wels, 82.           | Zebra-Shark, 106.    |
| <i>Umbrina</i> , 64.        | Whip-Snakes, 21.    | <i>Zeus</i> , 65.    |
| <i>Urogymnus</i> , 112.     | White-fish, 84, 86. | Zonuridæ, 7.         |
| <i>Uromastix</i> , 14.      |                     | <i>Zygæna</i> , 103. |

*John E. Hine*  
28 APR. 98













